CHAPTER 1

INTRODUCTION

1. This report is a further contribution to the discussion of the question of track costs which, over the last few years, has attracted a great deal of interest both in Europe and North America among government administrations, transport operators, trade unionists, commercial interests, academic economists and others. A large effort is being made within the European Economic Community to determine the right charging policy for the use of infrastructure (i.e. for the use of the track) so that the common transport policy which is being developed there shall be soundly based. In the United States, a very large programme of empirical work has been carried out.[1]

2. In the United Kingdom, interest has been stimulated through the publication of various pieces of evidence submitted to the Geddes Committee on the Licensing of Road Hauliers in 1964. These included submissions from the Ministry of Transport,[2] the Transport Holding Company,[3] the British Railways Board,[4] and others. The conclusions presented in them were by no means in agreement, either on fact or on principle.

3. In this context, "track costs" has generally been taken to mean the total costs of providing, maintaining and policing the public highway system. But the calculation of the total costs of roads is only the first part of the exercise: the next step is to attribute these costs to different categories of road user. The answers cannot be precise, because assumptions have to be made both about the magnitude of some of the costs and about the attributions, but it is hoped that, by setting out the further data that are now available and explaining in some detail the methods used and the assumptions made, the Report will lead to a better understanding of the problems that track costs present.

4. The Report deals not only with the costs of roads, but also analyses the revenue received by the Government from road users in the form of taxes. These taxes are not, of course, payments for the actual use of roads—they are part of the general taxation paid into the Exchequer and used, like other revenue, to meet the general cost of running the country. Nevertheless, it is of interest, in economic and financial terms, to compare the total revenue contributed by road users with the total costs of providing the roads and, in particular, to see whether the proportion of the total revenue contributed by any category of road user bears a close relationship to the proportion of the total cost that can be attributed to that category. The Report provides the basis for making these comparisons.

5. As was indicated in the 1966 White Paper on Transport Policy,[5] the Ministry is engaged in a substantial programme of economic research with the general aim of providing a firmer economic basis for decisions on transport policy. The main part of the work on inter-urban transport is the construction of an Inter-Urban Transport Costs Model, designed to forecast flows of traffic on certain routes and the cost of transport by the different main modes of transport on a number of assumptions about the division of traffic between modes. In the course of constructing this model it has been necessary to carry

---

[1] See Annex 1 [2] See Annex 2. [3] See Annex 3. [4] See Annex 4. [5] Cmnd. 3057.

out research into the costs of road construction and maintenance and other costs of road provision.

6. Some of the results of that research have been incorporated in this Report. But, just as the Ministry's general economic research programme is a continuing one, so the work on track costs will be continued and the results further refined.

7. This Report has several aims:

(i) To present new information that has become available since the earlier submissions, and so to reduce disagreement on the facts about track costs.

(ii) To analyse the present revenue from road user taxation, in so far as it bears on the principles on which road charging policy should be founded.

(iii) To describe briefly the research that is still in hand on road and rail costs, including track costs.

The Report has two additional aims, consideration of which cannot be exclusively economic nor the product of economic reasoning alone, since the principles that are to govern the level of taxation and its incidence on particular vehicle groups are ultimately matters of policy:

(iv) To discuss the economic principles which might, if no other considerations were involved, determine the method of charging for the use of roads; and

(v) To present the facts and reasoning which led to the proposal for the road haulage charge described in the White Paper on the Transport of Freight.[1]

While it is the task of economic research to provide an important part of the basis on which policies can be formulated and to work out the economic implications of adopting them, a report of this kind, involving as it does, questions of principle, cannot derive simply from economic research. It is the result of combining policy judgments with economic facts and reasoning.

8. The structure of the Report is as follows:

Chapters 2–6 deal with the overall relationship between road costs and revenues raised from road users. *Chapter* 2 determines which costs shall be regarded as road costs. *Chapter* 3 presents estimates of these costs for 1965/66, where they are quantifiable, and projections of these costs, on different assumptions, for 1975. *Chapter* 4 sets out the tax revenues raised from road users in 1965/66 and forecasts road user revenues for 1975. *Chapter* 5 considers various possible charging principles for roads. The first part of the chapter compares total road revenues with total road costs on three different bases; revenues are first compared with the costs road users might have to meet if roads were organised like a nationalised industry: then comparison is made between revenues and total public sector costs (i.e. track costs) and finally between revenues and total road costs i.e. including items, such as loss of amenity, felt by society at large. The second part of the chapter considers marginal theories or pricing, both short and long-run, which, though not currently practicable, offer, potentially, significant economic benefits if applied to roads. *Chapter* 6 points out that the levels of road user revenues and road costs bear no necessary relationship to each other, above all because the level of revenue paid by road users is determined by general fiscal considerations, e.g. the need to finance central government and to regulate the level of demand in the economy.

---

[1] Cmnd. 3470

9. *Chapters* 7–9 deal with the relationship between road costs and revenues for various classes of road user. *Chapter* 7 discusses the benefit/cost approach to the determination of the shares of total cost each should bear. This, while offering considerable economic advantages, is not currently practicable. *Chapter* 8 therefore discusses the cost responsibility approach to the determination of cost shares which is the best available approximation to the benefit/cost approach. Using this approach, total public sector costs are allocated to the various vehicle classes. *Chapter* 9 explains the arguments leading to the proposal to levy the road haulage charge.

10. *Chapter* 10 refers briefly to the research work on road costs under way within the Ministry.

CHAPTER 2

THE COSTS OF USING AND PROVIDING ROADS

11. This chapter discusses which costs should, in principle, be regarded as road costs. The following chapter will, where possible, provide estimates of these costs.

12. For most economic activities, it would not be necessary to ask the question: what are the costs of producing the goods or services concerned? Both private and nationalised enterprises maintain accounts, readily available, which give more or less detailed information on the nature and amount of the costs they incur. They may not be entirely comprehensive—many industries for example inflict costs on others, which are not reckoned in their accounts—but they provide a starting point for any investigation of the costs involved. But in the case of roads, largely for historical reasons which are discussed in Chapter 6, not even these exist. For several reasons, this deficiency is not as surprising as it may at first appear. Roads are provided by numerous bodies and there is no unified corporate management responsible for *all* roads, both local and national. Nor is the provision of roads a business in the usual sense: the providing bodies are not in a position to compare outgoings with revenue earned as they do not levy charges. There is no need, therefore, for the basic management tool of a set of accounts. The various items of expenditure which this chapter of the Report argues should be regarded as road costs, have therefore been assembled from the very many sets of accounts to which they are pertinent; in some cases, where no useable figure exists, they have been estimated.

13. Costs can be conveniently grouped into three categories: *User*, *Public* and *Community*. *User costs* are costs, such as petrol, oil and tyres, and the time involved in travelling, which directly fall on road users. *Public costs* consist mainly of road construction and maintenance expenditures, and fall upon central and local government. *Community costs* are those occasioned by road users which do not fall on the road user himself nor on government, but on other members of the community.

Road Cost Categories[1]

TABLE 2:1

User Costs	*Non-user Costs*	
	(*a*) *Public Costs*	(*b*) *Community Costs*
Purchase of Vehicles	Capital: new roads and major improvements	Amenity loss through:
Running costs of vehicles,	Maintenance and minor improvements	(*a*) noise
(*a*) expenditure on fuel, wages, repairs, etc.	Cleansing	(*b*) fumes
(*b*) value of time spent travelling	Lighting	(*c*) other factors
Vehicle excise duties	Policing	Accidents,
Accidents,	Administration,	(*a*) lost output
(*a*) insurance payment	(*a*) regulation and policy	(*b*) subjective costs (grief, pain)
(*b*) subjective costs, (grief, pain)	(*b*) research	
(Rates)[2]	(*c*) administration of expenditure	
	Accidents (costs not covered by insurance payments)	

---

[1] See Notes on Tables (pps xx) for comments on the construction of this, and subsequent, Tables.

[2] See Annex 11.

Table 2 : 1 illustrates this classification by showing some of the more important cost items in each group. Some costs, accident costs for example, fall into each category. A motorist causes and suffers an accident. Whatever his insurance, it is likely that he will be put at least to some expense as a result. The state will often have to meet costs imposed on the National Health Service or pay social security benefits. Finally, there may be others affected by the accident, pedestrians or relatives of the motorist, who also experience costs arising from it. By the definition used here, the first group are user costs, the second public costs and the third community costs.

User Costs

14. This Report is principally concerned with the road costs which fall on the state and the community at large. By their nature, user costs, which include such items as payments for vehicles and their running costs, are met by road users in the same way as consumers of other services pay directly for what they get. The question does not arise, therefore, as it does with the other two categories, whether road users are meeting these costs. Consequently with the exception of one item which cannot be regarded as a direct payment for services received, user costs will be ignored for the rest of this Report and no estimates of their magnitude presented in the following Chapter.[1] The exception is taxation.

15. This is a cost to the road user, but it is different from other cost items because it does not represent the consumption of resources in the way, for example, that payments for vehicle and repairs do, but a transfer of incomes from one group, road users, to the state, and then subsequently to other groups of people whom the state wishes to benefit, or to purposes such as health and education, from which all benefit, but which are not self-financing. From the standpoint of the economy as a whole, therefore, such payments are not costs. But, from another point of view, this taxation may be regarded as being in part at least the way in which the road-using public reimburses the state for the costs the latter incurs in relation to roads. To include these payments *and* public road expenditure in the same expenditure account would, on this view, involve double-counting. Thus, irrespective of whether taxation is viewed as merely a transfer payment or as a form of reimbursement for the costs of road use, it should be excluded from an assessment of road costs.

16. But the amount raised by taxation may, precisely because it does not represent the consumption of resources by road users, be usefully compared with the total of the other costs, public and community, which are not borne directly by road users, to see what the relation is between the total payments by road users and the total costs incurred on their behalf. Such a comparison will be made in Chapter 5.

17. Finally, some explanation is needed of why congestion, which is widely held to be a social or community cost, is treated here as a user cost. When an additional road user enters a crowded street, his arrival has the effect of slowing down other vehicles and therefore of imposing costs on them in addition to

---

[1] For estimates of total user costs see Ministry of Transport Highway Statistics, H.M.S.O. (Annual).

those costs of using the street that he himself incurs. By well established economic usage, a cost which is imposed on another party, and is not recouped from the person who imposes it, is a "social" cost.[1] Thus in that sense congestion costs are "social" costs, caused, but not paid for, by the creator. But most of these costs (some fall on pedestrians) fall upon vehicle users, and are therefore met by them as a group forming, part of their time and operating costs, even if they are not met by each user individually. For this reason a charging policy based on the relation between road users as a whole, on the one hand, and the state and the rest of the community, on the other, would ignore congestion costs. Chapter 5, paras. 58–69, outlines a different approach, which, because it is concerned with the relations between different classes of road user, does take congestion into account.

Public Costs

18. A firm's costs are broadly defined by its outgoings. The problem of establishing accountability within a firm is to relate cost, and of course revenue, items to the activities which occasioned them. This is the principle which has been used here in listing those costs falling upon central and local government which can be related to the road system and which are in any sense substantial. Over most items shown in Table 2:1, there is no room for argument: capital, maintenance, cleansing and lighting would all obviously appear in any set of road accounts. Some items, e.g. policing, accidents not covered by insurance, and that part of administrative expenditure which is not concerned directly with the management of the other expenditure items, but rather with research, policy-making and regulation, are less straightforward. These, it could be argued, are community overheads, i.e. costs of a type to be met by the nation as a whole and not by particular parts of it.

19. Police costs raise this issue very clearly, since expenditures on the preservation of law and order, benefitting as they do the community at large, are of the very type which would lead to their classification as community overheads. But police time spent on traffic duties is not in the main spent preserving law and order. Traffic duties are more like the duties carried out by management and inspectorates to see that the process of manufacture within a factory keeps running smoothly, or by signalmen and traffic control staff on the railways to see that traffic runs efficiently and safely, than the ordinary criminal and administrative duties of the police. Furthermore, the fact that police carry out traffic duties at all is an historical accident—duties which came to them because there was no-one else to carry them out with the necessary authority. For these reasons, this Report will treat police expenditure on traffic duties as a cost of providing road facilities rather than a community overhead.

20. Second, there are those accident costs which fall on the state, only part of which is met by special charges levied by the national health service upon road users involved in accidents, or their insurance companies, the remainder being met indirectly through from tax and health insurance payments. These costs would not arise if the roads were not used by vehicles, and can therefore reasonably be regarded as the responsibility of the collectivity of road users.

21. Third, administration. Administrative costs incurred in the control and management of the other expenditure items already classified as road costs,

---

[1] Such a cost is sometimes called an external cost; see Annex 12.

such as road construction, maintenance and cleansing, are clearly just as much road costs as the items themselves. They are directly comparable to the overhead expenditure of any firm or industry. Research expenditures too are normally covered by the industry concerned. The exceptions occur where the industry is not financially strong enough to support the level of research required or where interests of national security come into play. Neither of these considerations applies to roads. The costs of policy-making and regulation may also be treated as a road cost on the ground that it is just as reasonable to make users pay if an industry is expensive to control as it is if it is expensive to manage.

22. Finally, a comment on capital expenditure. There is no question of this not being a relevant cost; the problem is entirely one of determining how a capital cost should be assessed for a particular time period. As accounts on a commercial basis have not been prepared for roads over the years no conventions have come to be accepted for presenting to current users the fact that they are enjoying benefits from a stream of past expenditure going back hundreds, if not thousands, of years. There are many possible ways of achieving this, all of them open to some objection on grounds of principle or difficulty of practical realisation through lack of data, and none of them therefore entirely satisfactory. In any case, it may be argued that this lack of accounts is an advantage as it allows a more forward looking method of treating capital to be employed, one which ignores past expenditures, and concentrates solely on current and future capital costs.[1]

23. For the purposes of this Report and following the lines of the Ministry of Transport submission to the Geddes Committee, two approaches will be adopted, a Current Expenditure and a Public Enterprise approach. The first of these is straight-forward; it simply involves taking the total capital costs incurred in a given year and attributing it to that year. The second is more complex and, by its nature, hypothetical. It involves attempting to reconstruct what might be the capital charge for roads if they had in fact been organised like a nationalised industry with its own set of accounts prepared on a normal commercial basis. The nationalised industries do not themselves present a uniform picture: consequently only one of them, the electricity supply industry, has been selected for the development of the analogy, since its economic circumstances most closely resemble those of roads: it is rapidly expanding, prosperous and a major investor of capital. It is not claimed that this is the only way, or necessarily, the best way, that a capital charge could be estimated, merely that, if roads were to be organised like other major state enterprises, this is the sort of treatment of capital that might, on currently available precedents, be adopted.

Community Costs

24. Most of the readily measurable costs arising out of vehicle use can be categorised as either user or public costs. However, there are other costs caused by vehicles: their effect on amenity through the noise and fumes they create, which is felt mostly by people who are not, at the time at least, vehicle users—by-standers, pedestrians, the occupiers of houses and workers at jobs situated close to roads. Most of these will, of course, at other times themselves be drivers

---

[1] See Annex 10.

or passengers but one cannot assume that the damage a man inflicts in one capacity cancels out the damage he receives in another. Those who will suffer, for example, from heavy vehicles driving through a residential street are unlikely themselves to consider this when buying the goods these vehicles are carrying. They may be quite willing to pay through higher prices for their goods for relief from noise and fumes, but there is no opportunity for such a preference to be expressed. Moreover, even if it can be assumed that on average road users suffer as much of these costs as they impose, there is a strong case for attributing costs, if possible, to those responsible. People are not often deterred from inflicting costs on others simply by the thought that others will inflict similar damage on them at other times and in other places.

25. The treatment of these community costs, however, presents formidable difficulties for four reasons. First, there are no generally accepted methods of estimating these costs. Some relevant data are presented in Annex 12 and estimates are available for a part of community accident costs. But for all the remaining items listed in Table 2:1, it is apparent that any estimate must be subject to a considerable margin of error.

26. Second, even if estimates could be prepared, they would only represent the costs road users impose, given the existing regulations (for example, on maximum noise levels) and the existing absence of any charges for these costs. If the full costs were known, and if road users were required to pay them, it is likely that, in many cases, rather than pay, users would prefer to fit devices to control, for example, noise or fumes, or to make fewer or different journeys, thus reducing the total of these costs. The more exact the relation between charges and costs, the more likely it is that road users would attempt to reduce the level of the costs they impose.

27. Third, as a corollary of the previous point, it would make little sense to attribute these costs to particular categories of vehicle, unless methods were available which were capable of bringing these costs home to those that caused them and of allowing for their attempts to reduce them. This is not the case at present. New methods of road pricing may make it possible though they are unlikely to be able to cope with all the effects that road use has on amenity. In the absence of sufficiently refined pricing methods, regulations may be used as a substitute, though not a perfect one, since they are neither costless to enforce nor as flexible as could be desired.[1]

28. Fourth, it may be neither economically sensible nor equitable to attribute some of these costs to road users and impose charges or regulations accordingly, if the same is not done in those cases where costs are imposed on road users by others (e.g. delays caused by pedestrians) or where others contribute to the total costs involved (e.g. air pollution). In brief, while it is clear that road users impose community costs, it is not apparent at the present time, how, and how much they should pay for them.

Conclusion

29. This chapter has distinguished three categories of road cost: User, Public and Community. The first of these gave rise to little comment. User costs are,

---

[1] See Annex 6.

by definition, met directly by users. Taxation paid by road users, because it does not represent the consumption of resources, may be set against the non-user road costs to see how total road user payments compare with the total costs incurred in road provision and use.

30. The second category, public costs, presented more difficulty, since it was not obvious exactly which public costs should be attributed to road users nor how capital expenditure, though clearly a road cost, should be attributed to vehicle users in any given year. It was argued that police costs, accident costs not covered by insurance, and all administration costs should be attributed to road users and not regarded as community overheads. Other items, such as capital, maintenance and cleansing are all clearly road costs. For capital, two approaches were suggested, the first to charge capital to the users in the year it is spent, and the second to estimate a capital charge on the basis of an analogy with another nationalised industry, electricity supply.

31. The third category, community costs, was by far the most complex of the three, presenting severe problems of evaluation. Unless more sophisticated methods of charging were used than are currently available, then regulations may, in any case, be a better means of dealing with them, than the imposition of charges.

32. Having determined what costs should be regarded as road costs, the next step is to present estimates, where possible, of their magnitude. This is done in the following chapter.

CHAPTER 3

ESTIMATES OF ROAD COSTS 1965/66 AND 1975

33. This chapter presents estimates of public and community costs for 1965/66 and 1975. No estimates are given for user costs since, as explained in Chapter 2, they are not directly relevant to the relation between road users and the rest of the community.

Public Costs 1965/66

34. Tables 3:1 and 3:2 show the level of the public costs of road provision in 1965/66 calculated on two different bases. The tables are identical, apart from the first item, capital.

TABLE 3:1

Public Road Costs 1965/66: Current Expenditure Basis

	£m.
1. Capital: New Roads and Major Improvements ...	179
2. Minor Improvements	36
3. Maintenance	96
4. Cleansing	23
5. Lighting	9
6. Policing	52
7. Administration	40
8. Accidents[1]	15
	450

Table 3:1 makes no distinction between capital and other types of expenditure and for this reason differs from normal statements of accounts which draw a distinction between the two. However, in the case of roads, the usual reason why this distinction is made—to overcome the lumpiness of capital expenditure and allow it to be spread out over a number of years—does not apply, since capital expenditure does not fluctuate widely from year to year. Further there are positive reasons for adopting this treatment of capital where it is feasible: in particular it avoids all the problems concerned with the treatment of depreciation and asset valuation and concentrates only on commitment of current resources.[2]

TABLE 3:2

Public Road Costs 1965/66: Public Enterprise Basis

	£m.
1. Capital charges	390
2. Maintenance	96
3. Cleansing	23
4. Lighting	9
5. Policing	52
6. Administration	40
7. Accidents[1]	15
	625

---

[1] The difference between the £15m. given here as the cost of accidents and the total burden of accidents costs (estimated by the Road Research Laboratory at £246m. for 1965) is that the bulk of the latter are costs which at present fall on road users through insurance payments. They are, therefore, a user cost.

[2] See Annex 10 for further discussion.

Table 4 : 2 illustrates the alternative approach to the treatment of capital referred to in Chapter 2. A figure for capital charges[1] replaces expenditure on new roads and major and minor improvements. The roads have not been organised like a public enterprise so that the reconstruction of a capital charge must inevitably be hypothetical and no single figure can claim unique authority.[2] The figure shown here, then, can only claim to be illustrative.

35. All items apart from capital charges are common to both tables. Most of the figures, those for new construction, major improvements, maintenance and minor improvements and cleansing, are similar to those published in Highway Statistics. A detailed account of their derivation is given in the Notes on Tables at the end of this Report, but some salient points can be picked out here. Administration comprises central government expenditure on research, regulation and policy making as well as local and central administrative expenditures, associated with the provision of road track. The estimates of police costs differ from those used previously by the Ministry as data have recently become available which allow a more informed estimate than hitherto possible. As a result, a rather lower share of total police costs have been allocated to road users. As before, lighting expenditure is only intended to cover trunk and some other major roads. Finally, the cost of accidents not covered by insurance has been estimated on the basis of research carried out within the Ministry. A note on the estimation of accident costs is contained in Annex 12.

Community Costs 1965/66

36. Community costs present severe problems of evaluation and it is only for accident costs that the Ministry feels it can advance a figure with confidence. The principle community economic cost arising from accidents is the loss of output (and consequently of personal and corporate savings) arising out of fatal and serious personal injury accidents. These losses are felt by the community at large, on the assumption that such savings would have been invested profitably to the benefit of the economy as a whole. They have been estimated at £30m. for 1965/66. On one possible basis of assessment, the community subjective costs (i.e. the grief and pain suffered by non-vehicular road users) may be put at between £30m. and £40m. Some more tentative estimates of other community costs are given in Chapter 5, paragraphs 50–51.

Public Costs 1975

37. There are many difficulties involved in forecasting public expenditure even as far as ten years ahead. Up to 1970, estimates of expenditure levels on the main items can be fairly precise. After that date, prediction is more difficult, since much less is known about the likely performance of the economy and the level of other claims on national resources. Two sets of expenditure figures, a high and a low, have therefore been prepared for this Report for each of the two methods of treating capital outlined above.

---

[1] See Annex 13.

[2] Annex 10 discusses the difficulties involved.

[3] See Annex 12.

TABLE 3:3

Public Road Costs 1975: Current Expenditure Basis

	High	*Low*
1. Capital: New Roads and Major Improvements	740	425
2. Minor Improvements	60	47
3. Maintenance	157	126
4. Cleansing	38	30
5. Lighting	15	12
6. Policing	85	68
7. Administration	65	53
8. Accidents	22	18
Total	1,182	779

TABLE 3:4

Public Road Costs 1975: Public Enterprise Basis

	High	*Low*
1. Capital Charges	930	715
2. Maintenance	157	126
3. Cleansing...	38	30
4. Lighting	15	12
5. Policing	85	68
6. Administration	65	53
7. Accidents...	22	18
Total	1,312	1,022

The high and low cost levels are not intended as forecasts but as limits within which the true figure will probably lie. They have been obtained by applying two sets of assumptions to current expenditure levels; the high figure assumes that total expenditure will increase rather faster than traffic, the low figure that it will increase rather slower.

Community Costs

38. No estimates are presented here. Even though it would be possible to estimate a figure for community accident costs on the basis of current trends, there is little point in doing so, as it is hoped that the measures taken to improve road safety will significantly alter these.

CHAPTER 4

ROAD REVENUES 1965/66 AND 1975

39. Road users currently contribute to Government revenues in three principal ways: through payments of purchase tax, fuel tax and vehicle excise duties. The Transport Bill, now before Parliament, proposes, in addition to these, a road haulage charge on heavy goods vehicles.

40. Road users also pay a number of fees—for example, for driving tests and the issue of driving licences—which, for convenience, have been regarded in this Report as direct offsets to the services they receive.

41. The fuel and purchase taxes and vehicle excise duties fall on road users in different ways. Purchase tax is now levied only on cars and motor-cycles. It represents a once and for all payment, made at the start of a vehicle's life. Thus, it in no way affects the extent to which vehicles make use of the roads and therefore cannot be regarded as part of any charging system. Its main effect is on the number of cars and motor-cycles bought, rather than the total number in use, and is, therefore, of importance mainly as a regulator of spending in the economy. For this reason, while it has been included in Table 4:1, it has not been taken into account in subsequent calculations.

42. Fuel tax and vehicle excise duties are paid by all vehicles but in different ways. The fuel tax is paid by all vehicles at the same rate per gallon (though there is a special rebate on certain types of passenger bus operation); the incidence of the tax depends on the amount of fuel consumed. The vehicle excise duties on the other hand are levied at different rates according to the characteristics of the vehicle. Cars pay much less than heavy commercial vehicles, and there is considerable differentiation among the latter, according to their unladen weights. Buses, however, pay on the basis of the number of seats they provide, and some categories of vehicle enjoy reduced rates because of the special conditions under which they operate or because of the nature of the industry they serve.

43. Table 4:1 shows the amount of revenue raised from road users by the three principal taxes in 1965/66. The total raised excluding purchase tax was £926m. If the road haulage charge had been levied in that year it would have brought in approximately an additional £30m.

TABLE 4:1

Revenue Raised from Road Users 1965/66

	£m.	£m.
Fuel Tax	679	
Vehicle Excise Duties	247	
Total excluding Purchase Tax		926
Purchase Tax		144
Total including Purchase Tax		1,070
Road Haulage Charge (notional)		30
Grand Total		1,100

44. Table 4:2 presents estimates of receipts from fuel and purchase tax, vehicle excise duties and the road haulage charge for 1975. These have been made by applying rates applicable in 1965/66 to estimates of the number of vehicles and their use in 1975. In recent years there has been no decline in vehicle usage (i.e. the number of miles run by each vehicle), even though road space has been increasing less fast than vehicle numbers. Consequently, these estimates have taken no account of the possible levels of road expenditure between now and 1975.

TABLE 4:2

Revenue raised from Road Users: Estimates for 1975

	£m.	£m.
Fuel Tax	1,148	
Vehicle Excise Duties	419	
Road Haulage Charge	37	
Total excluding Purchase Tax		1,604
Purchase Tax		291
Total including Purchase Tax		1,895

CHAPTER 5

THE RELATIONSHIP BETWEEN TOTAL COSTS AND REVENUES: COMMERCIAL AND ECONOMIC APPROACHES

45. Separate revenue and cost figures have been presented in Chapters 3 and 4. What, if any, should be the relationship between them?

46. This chapter will consider a number of approaches to this question; in doing so, it will leave on one side the general revenue and regulatory functions of the taxes paid by road users. These will be returned to in the following chapter, and the relevant qualifications added to the argument of this. In this chapter, road user taxation will be regarded as a system of charging for roads producing revenue or income which may be set against the costs incurred for road users, in whatever is considered the appropriate way. Four possible charging principles will be examined.

- (*a*) The public income and expenditure account basis.
- (*b*) The public and community income and expenditure account basis.
- (*c*) Short run marginal cost pricing.
- (*d*) Long run marginal cost pricing.

(*a*) The Public Income and Expenditure Account Basis

47. This charging principle is a very straightforward one; all that is required is that the revenue paid should cover the public costs incurred in any given year. The only complication, the appropriate treatment of capital, has already been discussed in Chapter 2 where two alternatives were suggested. The first, the current expenditure approach, looks only at the total expenditures incurred by local and central government for road users in a given year, the second, the public enterprise approach, illustrates what level of charges users might have to pay, were roads organised like a nationalised industry. The cost figures appropriate to each alternative were given in Tables 3:1 and 3:2 respectively.

48. The difference in the cost levels shown in these two tables does not in practice present much difficulty. A comparison of costs and revenues on either basis shows a clear surplus, though not of course of the same size. A comparison of Tables 3:1 and 4:1 (current expenditure basis) shows a surplus of £476m. in 1965/66 (£620m. if purchase tax is included), while a comparison of Tables 3:2 and 4:1 (public enterprise basis) shows a surplus of £301m. (£445m. if purchase tax is included). Comparison of the Tables for 1975 show similarly large surpluses.

(*b*) The Public and Community Income and Expenditure Account Basis

49. A comparison of public costs and road user revenues shows an impressively large revenue surplus, but there are strong grounds for arguing that for roads this is not the right basis of comparison. Table 2:1 lists some additional costs categorised as community costs: loss of amenity due to vehicle noise, fumes and other factors and accident costs. There can be few economic activities, if any, which impose no community costs under these heads, but in the case of roads such costs are likely to be much more important than in other industries. Roads are found in all parts of urban and rural areas—residential, commercial

and industrial: they are not, as are most industries, confined to certain parts of the country or to certain parts of towns. Further, roads assets are intensively used being available throughout the day and heavily used for nearly half of it. *Prima facie*, therefore there is a strong case for bringing in these additional costs, and constructing a combined public and community account designed to include all the costs imposed by road users on non-road-users.

50. But, as the discussion of community costs in Chapter 2 has already made clear, there are formidable difficulties of practice which prevent the construction of such a combined account at the present time. In the previous chapter, estimates were presented of community economic and subjective accident costs, £30m. and £30–40m. respectively, which, provided that the basis of assessment is accepted, can be regarded as fairly firm. But in addition to accident costs, there are the costs of noise, fumes and other aspects of amenity impairment, such as the visual intrusion of parked vehicles, for which it is not possible to advance figures with this degree of confidence.

51. An estimate is available of the total costs of air pollution in this country, about £350m. in 1965/66, though only a fraction of this is due to motor-vehicles. However, if only one quarter of this sum were the responsibility of road users, and there is some evidence to suggest that this may be a not inappropriate figure, the costs due to road use would lie between £80m. and £90m.

52. No such global estimate exists for the other categories of community cost. Considerable work has been done on the measurement of noise and in estimating some of its effects. There is some information, for example, on the extent of severe traffic noise in urban areas and consequently it is possible to estimate the numbers of people at home or at work who suffer from severe noise levels. Such information in itself does not lead to a measure of the costs involved, but consideration of the costs of protecting this number of people from severe noise, suggests these costs may be considerable: on one possible basis of assessment they may be put at between £35m. and £40m. On other community costs much less is known.

53. There are yet further difficulties in drawing up the combined public and community cost account. The first of these has already been referred to in Chapter 2, para. 26. Even if it could be shown that the sum of community costs exceeded total revenue, it would not follow that the account should be considered to be in deficit, since if road users were charged these costs, particularly if this were done in a way that related charges closely to the costs imposed in each individual case, then they would take steps to reduce them, and in doing so, possibly bring the account in balance.

54. The second difficulty arises if the costs were shown to be lower than the revenues. It again would not follow that the surplus should be considered to be the full extent of the difference and charges consequently reduced. For the extra journeys that the reduction would stimulate, would, in their turn, occasion additional community costs.

55. Third, it may be argued that if community costs are to be brought into the reckoning so also ought community benefits, i.e. the benefits that accrue from the existence or provision of roads, to non-road users. This argument is

correct, but the bulk of what are often called the community benefits of roads arise directly through road use and in any case are taken into account when the likely demand for a new road is estimated: for example, many of the benefits that industry may enjoy from the provision of a new road are derived from the quicker journeys that it allows. These improved communications may lead to a faster rate of economic growth in the region affected, leading to higher incomes for its inhabitants. These benefits are only obtained through road use, originating as they do in the time and operating cost savings that the road improvement allows.[1] In this instance, it would be logically incorrect to postulate a community benefit which is more than the sum of the benefits to individual road users.

56. Entirely different are cases where the construction of a new road provides benefits to non-road users in ways which do not involve the use of the road as a track for vehicles: for example, the creation of rights of way or the provision of employment to unemployed workers in a recession. In principle, such instances should be taken into account, but, in practice, community benefits of these kinds are unlikely to be of general importance in British conditions or are likely to be offset by similar community costs. It is difficult to identify categories of benefit created by roads, which are not gained through road use,[2] while it is clear that the effects of vehicles are scarcely, if ever, positively beneficial to the environment.

57. In conclusion, while there are strong grounds for arguing that the combined public and community account is the right basis of comparison between road user costs and revenues, the difficulties of realisation are such as to prevent the construction of one at the present time. However, recognition of the potential importance of the additional community costs not included in the public account, implies that no clear view can be taken of whether or not public and community costs combined exceed revenue or the reverse.

Marginal Theories of Charging

58. The next two charging principles to be considered are entirely different from the previous two. They are not concerned with the overall balance between revenues and costs, which is of financial rather than economic importance, but with the use of prices to allocate resources efficiently between one use and another. The rule usually advocated to achieve efficient allocation is that the price charged should be equal to the marginal costs of producing the goods or services concerned. As the following paragraphs make clear, there are, in principle, considerable advantages to be gained from applying such a rule to roads. Its principal drawback is the lack of a charging mechanism to apply it. Until mechanisms of the required flexibility are available, marginal theories must be regarded as impractical. However, as was indicated in the White Paper on Transport Policy,[3] the Road Research Laboratory has been given the task of assessing the technical feasibility of new forms of charging which may have the characteristics required to charge prices on the basis of marginal cost. If some such systems are shown to be technically feasible, then further studies will be needed of such factors as the administrative difficulties, the total system costs and their likely efficiency in making for a better use of roads,

---

[1] See Annex 3.
[2] See Annex 9.
[3] Cmnd. 3057.

before it is possible to decide their overall feasibility. Because this has not yet been demonstrated, the discussion of marginal theories of charging which follows is designed only to indicate in broad terms their economic justification and to outline briefly how they might be applied.

(c) Short-run Marginal Cost Pricing

(1) *The principle*

59. Once the decision to provide a certain volume of output is made and capital invested, the only resources affected by the decision to produce a unit of output, say a vehicle mile, are those which vary directly with the level of output. Other costs are either irretrievably sunk in fixed capital or are committed in such a way that the resources cannot be released quickly for other uses.

60. The short run marginal cost (S.R.M.C.) pricing rule suggests that such costs should not be reflected in the charges made to consumers, since the allocation of these resources cannot be altered. Only those costs which are immediately responsive to changes in the level of output should appear in the charge. If charges do not so reflect costs (if, for instance, they are made to reflect the fact that on a particular road a large amount of capital expenditure has been made in the past), then users may be led to choose a service or product which is more expensive in terms of current resources used; or, in the extreme case, if the charge is too high, they may not consume it at all, even though they may be prepared to pay for the actual resources used up. (This is the logic of a much better known business and economic proposition: that if a mistake has been made and over-investment in capital equipment has occurred, there is no point in trying to set a price to cover all costs including capital costs. That policy will drive away custom and reduce profits by more than a policy which attempts to maximise net revenue as long as revenue exceeds the marginal or variable costs of production.)

61. This theory of charging appears particularly suitable for roads for two reasons. First, the gap is very large for most roads between total and marginal costs. For example, a motorway may cost £50,000 a mile in terms of an annual capital charge, but the running costs, including policing, which may be taken as a fair approximation to marginal costs, may be as little as £3,000 a mile per annum. Once such a road is built an additional user imposes very little extra public cost; furthermore the bulk of road capital expenditure is on carriageways, embankments, drainage works etc., so that, once committed, resources cannot be switched to other uses even in the long run. If the proportion of capital and other long run costs is high, then the difference between prices based on total and short run marginal costs will be considerable, and consequently the potential for greater efficiency by introducing a short run marginal cost policy is in principle correspondingly great.

62. Second, the gap in time between investment in a road and its replacement or expansion is usually very long by ordinary industrial standards. Only on the routes of fastest traffic growth will the gap be less than 15 to 20 years. It is much longer than that on most roads. Thus it is only infrequently that central or local government has to consider whether rising traffic on any particular

road is going to necessitate long run capital expenditure rather than the relatively small short run marginal cost of maintaining a road. It follows that because total costs are large relative to short run costs and incurred infrequently, there are long periods when the chief problem from the point of view of obtaining an efficient use of resources is getting the best use of existing resources, that is, pursuing a short-run marginal cost policy.

Application of Short-run Marginal Cost Pricing:

(2) *Application of the principle*

63. If it is accepted that the application of this rule would, in principle lead to the economically most efficient use of the road system, how would it work out if applied to roads? The purpose is to enable users to make efficient choices by presenting them, when they are faced with alternatives, with charges that reflect the public and community costs of those alternatives. Table 5:1 shows there is a wide range of variation in the public costs of providing roads of different types.

TABLE 5:1

Maintenance costs by type of road

	Cost per mile of road £	*Cost per* 1,000 *vehicle miles* *pence*
Trunk Roads	1,047	60
Classified Roads		
I	883	100
II	670	117
III	394	316

This remains true when the costs per road mile are converted into the more meaningful statistic of pence per thousand vehicle miles, by averaging the cost over the number of vehicles using each type of road, weighted by the distance they travel on that type. But even these figures do not reflect the full range of variation since they are averages over road types. If costs vary in this way from one part of the road network to another, it is possible to argue for a system of road charging which, by reflecting them, would encourage users to travel where marginal public costs were low and vice versa. This would, for instance, lead to lower average charges per vehicle mile on motorways than on country Class III roads, not because of the relatively infrequent use of them that has been allowed for in Table 5:1, but because the wear and tear effect of any given vehicle tends to be greater on the less trafficked roads.

64. The benefits of such a system have not been estimated. They may not be large, for although the proportionate variation in marginal costs from one road to another is large, the absolute figures are not great, hence the proportion of users diverted to low marginal cost roads would possibly be low. At the same time use of marginal public costs as the basis of charging suffers from an important disadvantage: if marginal public costs are below average public costs, as is almost invariably the case on the road system, then total costs will not be covered. To illustrate: on certain broad assumptions marginal public costs are represented by the cost items shown in Table 5:2 which are £258m. less than the cost items shown in Table 4:1.

TABLE 5:2

Marginal Public Costs 1965/66

	£m.
Maintenance	96
Cleansing	23
Lighting	8
Policing	50
Accidents	15
	192

On the other hand, if this were to be judged the correct pricing rule, the surplus of 1965/6 revenue over short run marginal public costs is £734m. but this surplus in itself is of no importance in the context of this rule, which is justifiable only in terms of the difference it makes to the pattern of road use, which, as indicated above, is unlikely to be considerable.

65. This rule could have much more important consequences, however, if, instead of merely reflecting differences in marginal public costs, variations in congestion costs were also included. The economic case for doing this was made in the Report of the Smeed Committee on Road Pricing,[1] and it was indicated there that the economic benefits of making charges reflect congestion costs might be very high, particularly in urban areas, where congestion costs, which are all by nature short run, are much greater than public costs. While the S.R.M.C. rule might also be applied to rural roads because congestion levels are much lower, its effect would be far less important, even negligible.

66. The inclusion of congestion costs in charges represents an approach to charging policy quite different to any so far considered. Up to this point, the revenue-cost relationships reviewed have been between road users and non-road users, either the state or the community as a whole. But congestion costs, as was pointed out in para. 17 of Chapter 2, are already borne by road users as a group. The purpose, therefore, of reflecting congestion as well as other costs in charges, is to bring about the correct revenue-cost relationship between each user and other users, as well as between users and non-users.

67. If congestion costs were included in charges, it is not clear how revenues would compare with total public costs. It is perfectly possible, because of the large amount of congestion in urban areas,[2] that receipts would cover these costs: they might even exceed the amount of revenue raised now. But it cannot be inferred from this that road users would be worse off, because they would, at the same time be gaining through the reduction in congestion costs (which fall on them) that this system of pricing should lead to. By discouraging road use on congested roads and encouraging it where there is plenty of capacity, it would lead to a pattern of utilisation of the road network that was better from the point of view of users. Journeys would be quicker and cheaper in terms of operating costs, and it would be these benefits that would provide the justification of this system of pricing, not the level of revenue it produced.

68. But, as explained above, it is not feasible at present to set charges according to S.R.M.C. whether this includes congestion or not. The available charging

---

[1] Ministry of Transport, Road Pricing: the economic and technical possibilities (Smeed Report H.M.S.O. 1964.

[2] See Annex 8.

and taxing mechanisms, fuel tax, excise duties, tolls, are insufficiently flexible.[1] While they are fairly efficient at reflecting the average costs of providing for each vehicle type, they are of little use in reflecting costs from one part of the road network to another and at different times of day, a facility which S.R.M.C. pricing requires, since short run costs, congestion in particular, are highly variable in space and time.

69. The work being done by the Road Research Laboratory referred to in para. 57 is aimed at discovering whether or not charging devices that offer the required flexibility are feasible.[2] Only if one or more such devices were found to be practicable and are in fact introduced, would it be possible to effect a thorough S.R.M.C. pricing policy. If they are not, other methods of pricing, much cruder, but useful nonetheless, may be used.[3] It is improbable, however, that any of these could be used on their own to establish a revenue-cost relationship for roads as a whole. Their uses if any would probably be as an adjunct to one of the other revenue-cost relationships discussed in this Report.

(*d*) Long Run Marginal Cost Pricing

70. In situations where it has not proved possible to apply S.R.M.C. pricing, some economists have turned to long run marginal cost (L.R.M.C.) pricing. Long run marginal cost is defined to include all costs associated with the production of an extra unit of output, capital as well as running costs. Consequently, and this is the main justification for this charging principle, existing users pay the costs that actually will have to be incurred to replace the facilities they are using and additional users pay what it costs to provide for them. Thus charges calculated on this basis do not relate, as they do in commercial enterprises, to costs that have been incurred in the past, but to the costs that would have to be incurred to produce an additional unit of output on an entirely new facility. Thus, if on average total costs of provision are falling, charges will fail to cover past costs, while, if they are rising, they will more than do so.

71. In the case of roads, there are peculiar difficulties involved in determining what long run marginal costs are. Unlike electricity supply, where the theory of L.R.M.C. pricing is most thoroughly developed[4], demand in one place cannot be met by facilties located in another. Further, capital invested in road has virtually an infinite physical life, so that in practice it is not necessary to replace capital, only to add to it or modify it to meet additional demands. For these two reasons, the concept of L.R.M.C. cannot, in terms of its strict definition, be applied to roads.

72. These difficulties with capital can, however, be overcome by charging for capital expenditure as though it were a current item i.e. in the year it is spent. This approximation retains the main merit of this charging principle of looking only at actual commitment of resources and disregarding past expenditures.[5] All other costs can be treated similarly, since there is no reason to expect any large changes in their level per vehicle mile in future years. In practice, therefore, L.R.M.C. pricing is equivalent to the current expenditure version of the Public

---

[1] See Annex 16.
[2] See Annex 7
[3] See Ministry of Transport, Better Use of Town Roads, H.M.S.O. 1967.
[4] See J. R. Nelson: Marginal Cost Pricing in Practice, Prentice-Hall 1964.
[5] See Annex 17.

Income and Expenditure Account Basis discussed above. In principle, L.R.M.C. may be defined to include community costs as well, but estimates of the future levels of these costs are even more difficult than estimates of their present level, which as the discussion above showed, are currently impossible. In practice, therefore, it cannot be determined how the revenue produced by charges set on this basis would compare with current community cost levels.

73. Besides this difficulty of practical application, L.M.R.C. suffers from two important weaknesses as a charging principle for roads. First, the charging mechanisms are not available to enforce this policy any more than they are for S.R.M.C. pricing. It can only be applied to roads as a whole. Consequently, L.R.M.C. charging could only represent the costs of providing for particular users or user classes, insofar as they made use of the roads in an average way and did not confine themselves either to roads needing improvement or to roads with spare capacity. Second, even if they were, it would not be feasible to distinguish between small parts of the network for charging purposes. Although it might be possible to draw a distinction between L.R.M.C. in urban and in rural areas, the rural network would have to be treated as a whole, since if charges were set higher on one part because a great deal of expenditure was being incurred on it, road users would divert where possible to other parts. Such diversion would not necessarily be welcome as it is generally desirable that improved roads should be used in preference to unimproved, because they are usually uncongested and are less expensive to maintain per vehicle mile run on them.

74. To sum up, although L.R.M.C. pricing is not so easy to apply to roads as it is to some other economic activities, it nevertheless retains significant economic advantages over other ways of charging capital costs to road users. For this reason, and because L.R.M.C. for roads as a whole is adequately approximated by charging all expenditure to users as it occurs, the current expenditure basis will be employed in the cost allocations presented in Chapter 8.

CHAPTER 6

THE RELATIONSHIP BETWEEN COSTS AND REVENUES: FISCAL CONSIDERATIONS

75. The previous chapter reviewed a number of possible relationships between road costs and revenues. None of these represents the present situation since no necessary connection exists between the level of road costs, public or community, and the level of taxes paid by road users. Why this is so, can best be shown in terms of the historical development of the road system.

76. Apart from the early turnpike trusts, which were eventually eliminated by the competition of the railways and which in any case covered only a small part of the road network, roads have been provided in the U.K. out of public funds, initially by local authorities, and later on, both by central and local government. Local authorities had to finance such works out of rates and were never in a position to charge for the services they provided. When central government took over responsibility for grant-aiding the building of new roads and improvement of existing ones, new taxes were instituted, the vehicle excise duty and a motor spirit duty, which were intended to finance a Road Improvement Fund to pay for these works. In practice, however, only a small proportion of total expenditure on roads was met in this way, as the largest element, maintenance, continued to be met out of rates. Police expenditure was financed in this way too. Consequently the accounts of the Road Fund never represented the total cost of providing roads and associated services.

77. There was, too, considerable opposition to the principle of bypothecating the yield of particular taxes for road purposes. The motor spirit duty was repealed in 1920. Its successor, the present motor fuel duty was introduced in 1928 and has always been treated as a general revenue duty. In 1937, the automatic commitment of licence duty revenue to the Road Fund was ended (the Road Fund had in any case been used for non-road purposes before then). All receipts have since been treated as general taxation. Road expenditure by central government has been financed from the Consolidated Fund and that by local authorities from rates or central government grant. The decisions and policies concerning expenditure are quite distinct from those relating to revenue. In particular, the latter are determined with regard, *inter alia*, to the public sector's overall financial requirements and the need to regulate the level of demand in the economy.

78. This means that the comparisons of costs and revenues presented in the previous chapter cannot be used to deduce any conclusions about what the level of either should be. And, further, if a S.R.M.C. pricing policy were to prove feasible, charges could not be set solely with regard to the short run costs on each stretch of road, but would also have to take into account the total revenues raised by any proposed set of charges.

79. To summarise the argument of Chapters 5 and 6:

(i) If a public sector income and expenditure account is drawn up for roads, it is in substantial surplus. But this raises the question whether this is the right basis of comparison, especially given the importance of community costs arising from road use.

(ii) When a combined public and community income and expenditure account is drawn up, it becomes indeterminate whether it is in surplus or deficit. This is because of the important cost elements which it is impossible to quantify within wide margins of error or at all.

(iii) If the Government were to wish to adopt short run marginal cost pricing, the methods of charging do not now exist to make it feasible. If it were introduced, it is not clear that such a system would mean raising more or less revenue from road users. Even if it produced more, it would not follow road users were made worse off: they would benefit from a reduction in their time and operating costs through the decongestion which this selective system of charging would achieve.

(iv) A system of long run marginal cost pricing which many economists have advocated as efficient, would, in the circumstances of the road system, probably not lead to an overall balance between revenue and costs different from that described under (ii).

(v) However, all these, though useful and suggestive lines of thinking when it comes to formulating investment and other policies, are subject to the requirements of fiscal policy, which does not allow the unrestricted application of any of them.

CHAPTER 7

COSTS AND REVENUES BY VEHICLE CLASS: THE BENEFIT/COST APPROACH

80. The discussion so far has been in terms of the relationship between costs and revenues for roads as a whole. The remainder of this Report will be concerned with the problem of determining the appropriate revenue/cost relationships for different categories of road user.

81. The discussion of charging relationships in Chapter 5 concluded that, among the currently feasible alternatives, the long run marginal cost approach, which for practical purposes could be identified with the public sector current expenditure account approach, was the preferred method of charging users the total costs of road provision. Although subject to certain limitations in the case of roads, it retains the important merit of looking at the actual commitment of resources by raising a revenue equal to the resources that were actually being spent on roads. If this rule is valid for road users as a whole, it follows that it should apply to individual road users, i.e. that each road user should be charged the cost incurred for him.

82. This chapter will examine the benefit/cost approach, which is the appropriate interpretation of the long run marginal cost rule in the case of roads. The relationship between benefit and L.R.M.C. is not, however, a straightforward one. Existing arrangements do not allow road revenues to be related to particular expenditures. For example, the effect of a road improvement, especially in towns, may be to reduce the amount of tax paid, as fuel consumption is reduced. Growth of revenue comes, rather, from traffic growth. Consequently road investment can be justified only in terms of the benefits it brings, not the revenues it produces. To the extent that a vehicle class benefits from expenditure, it helps to provide the case for incurring it. Further, if it does not benefit very much, the consequence may be, not that it does not pay very much, but that the pattern of expenditure is changed in such a way as to exclude this class and consequently it would pay nothing at all. Similarly, if benefits for a particular vehicle class were very much in excess of costs, then more should be invested for it until this disparity were removed, and it would consequently pay more. In this way three elements, costs, benefits, and revenues paid should tend to equality. This is exactly what would happen were the roads run by an authority which could charge directly for what it would provide: it would be forced if, for example, it built a new road, to relate its charges for it to the benefits that each vehicle enjoyed on it. Otherwise they might not use it at all. Revenues and benefits would have to be related for this reason; costs would have to be related to both, otherwise it would not be worth incurring them. This should tend to be true for each class of vehicle as well as for users as a whole.

83. This approach, while offering, *prima facie*, very strong advantages, is nevertheless difficult to apply. Why this is so will be made clear in the latter part of this chapter, but before going on to the more detailed analysis, some general points must be made. First, this chapter is concerned only with public costs: the discussion in Chapter 2 indicated that although community costs

may be very important, they were not at the moment sufficiently quantifiable to allow them to be estimated in total, still less be related to individual vehicle classes.

84. Second, the previous chapter has made it clear that the L.R.M.C. rule cannot alone determine what the overall level of charges should be, even if it included community costs. Similarly, it is subject to fiscal and other policy requirements in its application to individual vehicle classes. For example, there are strong policy reasons for treating buses differently from other vehicle classes. A different limitation derives from the existing charging mechanisms, which may not allow the pattern of charges to be realised which this rule would suggest. For several reasons, therefore, the allocation of costs which may appear best from the point of view of roads and their users, may have to be modified.

85. Despite these factors, it is nevertheless worthwhile considering what would be the best solution without them, to indicate what should be done if they were removed and to provide a basis for any assessment of a modification suggested or imposed by them. Further, there are grounds for arguing that even if charges for each vehicle class cannot be equated to L.R.M.C. for that class, they should at least be related to it, as the White Paper on Nationalised Industries[1] suggests. In the case of roads, it would be undesirable to raise much more revenue in relation to long run marginal costs for one category of heavy vehicle rather than another, since this would bias choice between them in a way that would have no justification at all, at least in terms of road economics. It may, for example, discourage the use of vehicles which on an overall view, would be most economic. Such a policy might have undesirable long term consequences if vehicle design were affected and if the pattern of road investment were itself modified because a different mix of vehicle used the roads. Neither of these reactions would be justifiable in economic terms: they would only tend to confirm the initial distortion. In addition, it can also be argued that it is equitable for charges to have some definite relationship to costs.

Application of the benefit/cost approach

86. The apparently simple requirement, outlined in para. 82, that there should be close relation between the costs incurred for a vehicle class, the benefits it enjoys and the revenues it pays, is in practice very difficult to apply, for several reasons. The first of these arises from the phenomenon known to economists as joint costs, i.e. costs incurred jointly for a range of users all of whom benefit. The classic example is the production of wool and mutton. Although within limits it is possible to vary the proportions of each product, it is not possible to produce only one. Consequently it makes no sense to talk of the cost of producing either individually. The only cost is the cost of producing a sheep. Roads have similar economic characteristics: they are used by different vehicle classes which have different traffic characteristics. These may be termed the different products of roads. The sharing of road facilities takes place because, in most circumstances, it involves lower costs for all concerned: a separate track for each would normally be absurdly expensive, so expensive in fact that some classes of user would not be able to meet the cost. Because track is shared, expenditures necessarily affect all users, and hence they are joint. But where there are joint costs, it is ultimately impossible to determine precisely what

---

[1] Cmnd. 3437.

share of cost each class should bear by purely economic considerations. These may set a limit on the attribution of costs; for example, it makes no economic sense to attribute more cost to a vehicle class than it receives in benefits. If such a disparity exists, then the pattern of expenditures should be modified to bring costs into line. But within the limits set by economic considerations, costs can be shared only in some way that appears equitable.[1]

87. There are further difficulties on the benefit side. Economic appraisal of the benefits of highway improvement schemes is increasingly being used to determine priorities, especially in inter-urban schemes. These appraisals, which include estimates of the savings in time and other operating costs that accrue from road improvements, allow the estimation of the benefits accruing to each vehicle class, and it might appear, subject to the inherent limitations of these calculations (e.g. uncertainties as to the appropriate value of time), that these shares would offer a method of attributing costs on the lines required. These benefit calculations, which are appropriate for the evaluation of the effects of road improvements, are not, however, suitable for cost attribution, for two reasons.

88. First, they ignore the disbenefits that one class inflicts on another while using the joint facility. For the purposes of investment appraisal, in all but exceptional circumstances it is appropriate to assume that all vehicle classes use the road before and after an improvement; therefore no separate analysis is made of the benefits that are lost by a vehicle class in terms of the extra congestion it suffers because it must share with others. This would be irrelevant to the investment problem. However, it would be incorrect to ignore these when allocating costs, for both economic and equity reasons, as there can be no presumption that such losses cancel out between classes. Consequently, there is an obvious case for making vehicles which impose greater losses on other classes than they themselves suffer pay a greater share of the costs concerned. Not only might this be said to compensate the other vehicles for losses they receive but it recognises the fact that, because some vehicles contribute more to congestion than others, they bring forward more rapidly the date when further investment is required.

89. This difficulty could in principle be reduced by further refinement of the existing methods of investment appraisal. The second difficulty is more intractable; it can be illustrated by considering the case of a road to a particular location which is being improved, and where the costs associated, for example, with heavy vehicles, such as road strengthening and gradient reduction, which would not be necessary were they not to use the road, are greater than the apparent benefits they receive. It would appear to follow that the expenditure should not take place. Yet this is clearly unreasonable because it would involve their exclusion from the route. The reason for this apparent paradox is, again, that benefit appraisals take it for granted that all classes of vehicle will use a road and they therefore do not examine the consequences of exclusion. These would be longer, more roundabout, journeys, and possibly, if the road concerned were the only route available, loss of economic viability of the place served. Thus, while the benefit a heavy vehicle may derive from improvement may be small, the loss of benefit it would suffer if it were excluded from an improvement

---

[1] See Annex 15.

would almost always be extremely high. But the benefit of access is quite different from the benefits—time and operating cost savings—that current methods are capable of evaluating. Consequently it is not possible to estimate how significant this omitted item might be.

90. To conclude: the benefit/cost approach cannot, even in principle, provide a complete answer to the problem of determining how much each vehicle class should bear of the total costs of road provision. Because some road costs are joint, some indeterminancy must necessarily exist. It suffers, too, from practical difficulties, in that estimates of some of the relevant benefits are not available. Nevertheless, it retains considerable attraction in principle. It may, because it attempts to analyse as fully as possible the justification of expenditures, provide a check on them, and also suggest, in certain circumstances, modifications to the pattern of expenditures being incurred. In these ways, it relates, as closely as is possible, pricing and investment policies both for roads as a whole and for individual vehicle classes.

91. The approach adopted in the following chapter for the attribution of costs is as an approximation to that examined in this. It does not, as the benefit/cost approach would, in principle, examine in detail the justification for each expenditure item. It assumes that where expenditure is incurred because certain classes of vehicle impose special requirements, this is justified in terms of benefits to them. At the present time, it is not only reasonable to assume this, but it is in practice the only feasible approach.

CHAPTER 8

COSTS AND REVENUES BY VEHICLE CLASS: THE COST RESPONSIBILITY APPROACH

92. The approach considered in this chapter to the problem of determining the share of costs each vehicle class should bear is the same in spirit as that followed by the Ministry of Transport in its submission to the Geddes Committee.[1] The basic method is to consider each cost item in turn and attempt to isolate any component which can be said to be incurred for a particular vehicle class. Such costs are then allocated to that class. When this is done, the remaining costs can be shared between vehicles by some measure related to their use of the roads, e.g. vehicle miles. This approach may be justified in two different ways.

93. First, it represents the best approach currently available to the problem of economically distributing total costs between individual classes of vehicle. By isolating costs which are incurred only by one or more vehicle classes and attributing them to those classes, and by distributing the remaining costs among the different classes according to the extent to which the vehicles in each class make use of the roads, this approach ensures that as far as possible allocation of costs is directly related to the cost of road provision. Where there are no grounds for distinguishing between vehicle classes in terms of cost, then no differentiation is made between them. In theory this approach falls short of the benefit/cost approach in the determination of costs specific to particular vehicle classes. Because the benefit/cost approach probes deeper into the justification for expenditure decisions, it may indicate more precisely the extent to which costs may be identified with particular vehicle classes. But the previous chapter has illustrated the difficulties of applying the benefit/cost approach: given them, the cost responsibility approach is the best available approximation to it. Neither approach can, of course, indicate a precise and unique determination of cost shares, where there are joint costs.

94. Second, it provides an equitable basis for charging. It is obviously unfair to charge all user classes costs which only have to be incurred for one or two classes. Further, where there are no grounds in terms of cost to distinguish between vehicles, it would be accepted by most that no distinction should be made in charges. It is, of course, not the only possible equitable approach: it might, for example, be considered fairer if charges were related to ability to pay. But in the case of roads, this is not a readily applicable criterion. The criteria used in this chapter are, on the contrary, easy to apply.

95. Even though the cost responsibility approach has the basic economic justification outlined in paragraph 93, it suffers from important deficiencies, already mentioned in the discussion of the L.R.M.C. pricing principle. Because of the impossibility of charging for particular types of road or particular journeys, it is likely that the charge on some will be too high and on others too low. Thus only limited economic significance can be drawn from the fact that heavy commercial vehicles cover their costs as allocated here, or that any other vehicle class does. These costs are not the public costs that would be saved were

---

[1] See Annex 2.

these vehicles to cease to use the roads if, for example, traffic were transferred from road to rail. This is partly because the charges that result from allocating the total roads cost over all vehicles must necessarily be averages of cost conditions over all roads, and not only those on which competitive traffic move, but also because of the nature of road costs. In most circumstances a given percentage change on traffic will not lead to an equivalent proportionate change in cost, i.e. marginal costs are unlikely to be the same as average costs. In some circumstances they may be more, in others less. Wherever there are joint costs, and therefore the attribution of costs is uncertain, this is likely to occur.

Application of the cost responsibility approach

TABLE 8:1

Total revenue (fuel tax and excise duties only) contributed by each major vehicle category,[1] 1965/66

	£m.	Per cent of total
Cars	534	59·5
Public Service Vehicles ...	36	4·0
Light Vans	105	11·7
Heavy Goods Vehicles... ...	223	24·8
	898	100·0

96. Table 8 : 1 shows the shares of total revenue paid by each major vehicle class. These estimates, while subject to certain statistical qualifications, discussed in the Notes on the Tables, present no difficulties of principle. The next stage, however, of determining the share of costs to be attributed to each vehicle class is, for reasons already mentioned, much less straightforward.

97. The results of applying the cost responsibility approach to the determination of cost shares are shown in Table 8 :2.

TABLE 8:2

Total public cost allocated to each major vehicle category, 1965/66

	£m.	Per cent of total
Cars	253	58·0
Public Service Vehicles ...	24	5·5
Light Vans	33	7·6
Heavy Goods Vehicles... ...	126	28·9
	436	100·0

Detailed comments on the construction of this Table can be found in the Notes on the Tables, but some particular points will be mentioned here.

98. First, capital: the submission by the Ministry of Transport to the Geddes Committee provided estimates of the share of capital costs which is incurred solely because of the need to provide for heavy vehicles, principally extra carriageway and structural costs occasioned by their extra weight and height. Subsequent work has confirmed the general correctness of the earlier estimates,

---

[1] Motor Cycles have been omitted for reasons given in the Notes on Tables.

although in some cases the share quoted then—17½ per cent—is too high and in others too low. Research has suggested, for example, that in the case of minor improvement schemes, the figure is somewhat higher, about 20 per cent.

99. For the rest of capital expenditure, it is not so easy to identify any part of it with a particular vehicle class. This Report has modified the method used in the earlier submission, but it retains the assumption that heavy vehicles should pay more per mile than light. The argument for doing this is as follows: capital expenditure is required because roads are congested and speeds low. For rural roads, it has been estimated that on average a heavy vehicle causes three times as much congestion as a light and it was on this ground that the Ministry submission to the Geddes Committee allocated three times as much capital cost to each heavy vehicle mile as to light. But, for several reasons which are discussed at length in the Notes on the Tables, this relative weight seems too severe on the heavy vehicles, and accordingly in this Report they have been allocated only twice as much capital cost per mile as light vehicles.

100. Surface maintenance is the second item where the costs caused by heavy vehicles are very different from those caused by light. It is occasioned almost entirely by heavy vehicles. The engineering data still do not permit a precise allocation of this cost item between the different vehicle classes in British conditions, since there are strong reasons for thinking that the main source of information about relative maintenance costs, the A.A.S.H.O. tests,[1] is not directly applicable to roads in this country. But whatever the true relationship, it is certain to mean allocating nearly all surface maintenance costs to heavy vehicles. A rather more moderate relationship than the A.A.S.H.O. tests suggest has been used in this Report; nevertheless the result is that the vast majority of this cost item is attributed to heavy vehicles.

101. In the case of the remaining costs, other than accidents, there is little evidence to suggest that any class of vehicle is more expensive than any other to provide for. Consequently these costs have been shared out between each vehicle class according to the miles they run on the system. This allocation method has been applied to police costs, although the Geddes submission suggested that it might be more appropriate to use a measure which bore more severely on heavy vehicles. Evidence recently become available[2] suggests there is no case for this. Accident costs have been allocated according to the frequency of involvement each vehicle class has in accidents and according to the medical costs of the type of accident each tend to have.

102. The methods of allocation briefly outlined above lead to the cost shares shown in Table 8:2. Comparison of this Table with Table 8:1 shows that there is at present no exact correspondence between revenue shares and cost shares. Cars, for example, pay more in revenue, proportionately, than the costs allocated to them, while, for heavy goods vehicles, the situation is reversed. These results can be expressed in another way. The total public costs allocated to each class can be compared with the total revenues from the taxes they pay, and a ratio derived. The revenue cost ratios for 1965 are shown in Table 8:3,

---

[1] See Annexes 1 and 15.

[2] See Notes on Tables.

which indicates a considerable disparity between them. Table 9 : 5 in the following chapter shows that similar disparities exist between different classes of heavy goods vehicle.

TABLE 8:3

Revenue/Cost Ratios by Vehicle Class

1965/66

	Revenue: *Cost*
Cars	2·1:1
Public Service Vehicles	1·4:1
Light Vans	3·3:1
Heavy Goods Vehicles	1·8:1

103. In conclusion: allocations of total public cost have been effected in this chapter according to the cost responsibility approach, which is the best currently practicable method. They have resulted in the heavier vehicles being allocated much more cost than the light. But as the discussions of marginal theories of charging in Chapter 5 have made clear, there are in principle quite different bases of road charging, which, if introduced, might upset the pattern of cost allocations produced here. There are strong grounds for arguing that this is unlikely. If congestion costs were introduced into road charges, as the short run marginal cost approach would imply, heavy vehicles will in most circumstances pay much more than light on this account[1] so that the existing differentials would almost certainly persist. A rather different point is presented by the nature of the averaging between vehicles that the application of the cost responsibility approach at present implies. For statistical and administrative reasons, it is only possible for example to distinguish between heavy vehicles on the basis of their unladen weight, although there is some evidence[2] that it would be preferable to distinguish between them on other grounds. But even if this were done, it would alter the balance only between different types of heavy vehicles and not between heavy vehicles and other classes.

---

[1] See Annex 5.
[2] See Annex 8.

CHAPTER 9

THE ROAD HAULAGE CHARGE

104. In the White Paper on the Transport of Freight,[1] reference was made to the high proportion of road maintenance and construction costs attributable to heavy goods vehicles and to the Government's proposal that operators of goods vehicles over 3 tons unladen weight should pay a specific charge per vehicle which would reflect the extra wear imposed on the roads by such vehicles. The preceding chapter has already shown, in Table 8 :2, the relatively high proportion of costs that are attributable to heavy goods vehicles—28·9 per cent of total costs—although in numbers these vehicles represent only some 6·5 per cent of motor vehicles using the roads: Table 9 :1 illustrates these proportions.

TABLE 9:1

Vehicle fleet 1965

	Numbers in fleet ('000s)	*Per cent. of total*
Cars	8,917	84·6
Public Service Vehicles	97	0·9
Light Vans	845	8·0
Heavy Goods Vehicles	688	6·5
	10,547	100·0

Comparison of this Table with Table 8 :2 shows that the heavy goods vehicle, defined in this Report as a goods vehicle exceeding 30 cwt. unladen weight, on average incurs more than six times the cost attributable to a private car, i.e. £183 as opposed to £28. Chapter 8 has also demonstrated that the revenue contributed by heavy goods vehicles in terms of fuel tax and excise duties represents a rather smaller proportion of total revenue—24·8 per cent—than their share of total cost. This fact, that operators of heavy goods vehicles contribute less revenue in proportion to their attributable costs than owners of most other vehicles, has been taken into account by the Government in formulating their proposals for the new charge.

105. The general arguments which suggest that revenues and costs should be in the same proportion for each vehicle class have already been presented in Chapter 7. But these arguments are not necessarily decisive and may be outweighed in particular cases by wider considerations of national policy or practicability. The revenue/cost ratios set out in Table 8 :3 show that while private cars, which represent the numerical majority of motor vehicles using the roads, contribute revenue in a ratio of 2·1 to 1 to cost, the other classes differ widely from this. In the case of two of these classes, however, there are reasons which preclude the application of the general principle of maintaining the same proportion between revenue and costs for each class of vehicle. Because of the special role which public passenger transport has to play in the community and the financial support which the Government are proposing to extend to it as described in detail the White Paper on Public Transport and Traffic,[2] no increase in revenue derived from public service vehicles is proposed.

---

[1] Cmnd. 3470.

[2] Cmnd. 3481.

As regards light vans, it is not practicable to give the reduction which their high revenue/cost ratio would suggest. There are serious difficulties in lowering the fuel tax and excise duty for light vans below the levels for cars because of the possibilities of substitution between the two classes.

106. A further reason why it may be undesirable to keep revenues and costs in the same proportion is that for purely fiscal reasons—unconnected with any arguments about allocation of road costs—the Government may wish to increase or decrease the taxation levied on a particular class of road user without taking corresponding action *vis-à-vis* other classes. Fiscal considerations may also from time to time require changes in the duties on motor fuel which may affect the revenue/cost ratios differently.

107. Finally, the principle has not been applied with arithmetical precision. Table 9:2 shows the implications of applying the current revenue/cost ratio of private cars to heavy goods vehicles. If the revenue/cost ratio for these vehicles were to be raised to that for cars, then an extra £42m. would have to be charged.

TABLE 9:2

Revenue raised by applying car revenue/cost ratio to heavy goods vehicles 1965–66

£m.

(*a*) Costs allocated to heavy goods vehicles over 30 cwt.	(*b*) Revenue required to produce revenue/cost ratio of 2·1:1	(*c*) Revenue paid by heavy goods vehicles	(*d*) Revenue deficit (column (*b*) minus column (*c*))
126	265	223	42

The scale of the road haulage charge, has, however, been calculated to raise only £30m. on the basis of the 1965 vehicle fleet. The evaluation of track costs and their attribution to individual vehicle classes is not an exact science, and some margin needs to be left to allow for this fact. If a road haulage charge of this magnitude is assumed, the ratios given in Table 8:3 of the preceding chapter will be modified to the following:—

TABLE 9:3

Revenue/cost ratios by vehicle class assuming road haulage charge in force 1965–66

	Revenue: Cost
Cars	2·1:1
Public Service Vehicles	1·4:1
Light Vans	3·3:1
Heavy Goods Vehicles	2·0:1

108. The next question to be considered is the distribution of this £30m. among the various categories of heavy goods vehicle. Currently, the amount that heavy goods vehicles pay by way of excise duties and fuel tax rises with the weight of the vehicle. The excise duty scale is drawn up in relation to the unladen weight of the vehicle, but the effect per mile is somewhat different from what the annual amounts paid appear to imply, since the larger vehicles do more miles per year and therefore reduce the incidence per mile of the duty, which is fixed irrespective of miles run. Fuel tax obviously varies with the mileage run, but also with the type of fuel used, for although the tax per gallon is the same for petrol and diesel fuel, the greater fuel economy of diesel engines means that vehicles using

them pay less tax per mile than equivalent petrol engined vehicles. Nevertheless, as Table 9 :4 shows, the amount paid rises fairly steeply with the weight of the vehicle employed, the heaviest vehicle paying about 3d. per mile more than the lightest in this class; in annual terms, the heaviest vehicles pay on average about £800 more than the lightest.

TABLE 9:4

Estimates of total revenue (fuel tax and excise duties only) contributed by heavy goods vehicles; unladen weight categories 1965–66

Unladen Weight in tons	(*a*) *pence per mile*	(*b*) £ *per annum*
1½–2	3·1	161
2 –2½	4·4	202
2½–3	4·4	211
3 –4	4·1	325
4 –5	4·3	466
5 –6	4·8	540
6 –7	5·1	702
7 –8	5·5	802
8+	6·2	943

109. Despite the fact that the taxes levied bear so much more heavily on the large vehicles, their revenue/cost ratios, shown in Table 9 :5, are much lower than for the smaller. The reason is that the costs of providing for heavy lorries, in particular the costs of road surface maintenance and carriageway strengthening works, rise steeply with vehicle weight, even more steeply than the tax paid. This remains true even though, as the Notes on the Tables indicate, the relationships used in this Report to allocate these costs between different categories of goods vehicle are not as severe on the heaviest vehicles as some that have been proposed. Despite this, only a very small part of these extra costs is allocated to the smaller heavy goods vehicles; the bulk is allocated to the larger vehicles.

TABLE 9:5

Revenues, public costs and revenue/cost ratios for heavy goods vehicles before payment of road haulage charge; unladen weight categories 1965-66

Unladen weight in tons	£m. *Revenue*	*Public cost*	*Revenue: cost*
1½–2	12·7	6·1	2·1:1
2 –2½	16·2	6·0	2·7:1
2½–3	23·6	9·3	2·5:1
3 –4	58·6	34·5	1·7:1
4 –5	40·8	24·8	1·7:1
5 –6	19·3	12·4	1·7:1
6 –7	16·1	10·4	1·5:1
7 –8	13·8	8·5	1·6:1
8+	22·3	14·0	1·6:1

110. Another factor tends to suggest that the revenue/cost ratios for the smaller heavy vehicles are in any case rather lower than is justified. They contrast markedly with those for light vans despite the fact that their characteristics are not markedly dissimilar. This disparity arises from the method of allocating capital costs used in this Report which almost certainly bears too heavily on the smaller heavy goods vehicles, since each category of heavy goods vehicle is allocated the same amount per mile run of this cost item, while light

vans only attract half as much. Yet it is clear that this sudden change in treatment does not correspond to any change in costs. It derives in part from the statistical impracticability of distinguishing between different categories of light van, despite the evident range in their characteristics, and in part from the existing inability to distinguish between types of heavy vehicles for the allocation of this cost item, which is, however, the most important one, comprising as it does, about half of the total of public costs. Although general considerations suggest[1] that the heavier vehicles should attract more proportionately of these costs, there is no firm evidence to suggest what the relationship between weight and cost should be. The only firm information available is based on broad vehicle categories.

111. To sum up, not only are the revenue/cost ratios higher for the lighter heavy goods vehicles, but there are grounds for arguing that they are, in any case, allocated an unfairly high proportion of total cost. For these reasons it was decided not to apply the road haulage charge to these vehicles.

112. Above three tons unladen, the revenue/cost ratios fall sharply, reflecting the steep increase in the wear and tear costs of the heavier vehicles. At these weight levels, the revenue/cost ratios are well below that for cars. But as indicated in the previous chapter, the full amount of the revenue required to bring these ratios up to that for cars is not to be raised. Given the sum of £30m. to be raised, the existing pattern of revenue/cost ratios and the evidence adduced in Annex 19 in favour of a scale rising with the unladen weight of the vehicle, a scale running from about £50 for a vehicle of 3 tons unladen to £190 per vehicle per year for a vehicle of 8 tons and over is indicated. (The scale has not been extended beyond this point because the available statistical data do not allow the calculations required.) The effect of such a scale may be seen in the following table which represents a revision of Table 9:5 taking into account the additional revenue deriving from the road haulage charge.

TABLE 9:6

Revenue/Cost ratios for heavy goods vehicles after notional payment of the road haulage charge 1965-66

Tons unladen	*Revenue: cost*
1½–2	1·9:1
2 –2½	2·4:1
2½–3	2·3:1
3 –4	2·0:1
4 –5	1·9:1
5 –6	1·9:1
6 –7	1·8:1
7 –8	2·0:1
8+	1·9:1

113. The incidence of the proposed scale of charges varies from about 0·6d. per vehicle mile to 1·25d., depending on the size and utilisation of the vehicle affected. These figures represent cost increases of about 2½–3½ per cent. Even if it is assumed that all this extra cost is passed on to the user of road transport, its effect on the amount of traffic carried by road is likely to be small as may be seen by considering how responsive to a given increase in cost the demand for road transport would have to be for significant diversion of traffic to occur.

---

[1] See Annex 19.

114. For one thousand million ton miles of traffic to be diverted from road to rail, which is one sixteenth of the present long distance traffic carried by road,[1] the responsiveness of demand would have to be high, since a 3 per cent change in price would be causing a change in traffic twice as great. But for several reasons it is unlikely that demand should be as responsive as this. First, there was little or no sign of traffic diversion following the increases in the excise duties for heavy lorries introduced in late 1965, which were about half the level of the proposed charges. Second, quality of service factors in transport, as in other industries, are important, reducing the purely price effects. Finally, it is likely that the actual price increases experienced by users of long distance transport, which is a part of the road transport industry particularly vulnerable to rail competition, is likely to be low, since the charge will be spread over more ton miles than for the average vehicle. The incidence of the charge will be greatest for large vehicles engaged on local collection and delivery where rail is rarely competitive.

---

[1] Not all of this, however, would be suitable for carriage by rail, because rail facilities do not exist for the routes concerned, or because of the nature of the goods or transits involved.

CHAPTER 10

THE WAY AHEAD

115. As the Introduction indicated, and the Report itself has made clear, work on track costs within the Ministry has not reached finality. There are important gaps in our knowledge both on the total levels of certain cost items, and on the relation between certain costs and the use of the roads by particular vehicles. As more information is obtained, the calculations presented here may be refined. But improved data alone cannot solve the economic problems associated with track costs. The treatment of these problems raises questions of principle, as well as requiring economic facts and reasoning.

116. For all these reasons, a flexible attitude to track costs problems is required. There is a further reason. This Report has not considered the relationship between road and rail. The new policies announced in the White Paper on Railway Policy[1] should lead to marked changes in the relationship between total rail costs and revenues, invalidating any comparison between road and rail based on the current position. Nevertheless it remains one of the most important aspects of the track cost problem (though not, as is often argued, the only one), that policies for road and rail should be developed in harmony, and consequently a major part of the economic research being conducted at the Ministry is geared to considering the relationship between the two.

117. This research rests on two basic principles:

(*a*) that only costs that will or might have to be incurred in the future should be considered, and

(*b*) that the best way for research to lay the basis for policy decisions on track costs and other issues involving the relationship between the two forms of transport is to examine how total transport costs vary with various divisions of traffic between road and rail.

If this can be done, it will allow the implications of different policies to be examined, and the relative merits of each to be better evaluated.

118. This approach cannot produce answers quickly. The implications of various divisions of traffic must, because of the long life of transport investment, be considered some long way ahead—the Ministry has chosen 30 years. It must involve at least the whole of the main road and rail networks, which involves the predictions of both costs and demands over a number of routes, covering virtually all the flows between main centres. It must involve not only a projection of demand levels, but also an examination of the sensitivity of demand for each form of transport to the price and quality of the transport service offered by each mode.

119. Even this brief description implies a large programme of research. Much of it is under way at the Ministry at the present time. Already some results are available for various sections of the total programme, and it is intended to make preliminary results available over the next few months.

---

[1] Cmnd. No. 3439.

120. The work being undertaken will have many other uses than the provision of the framework within which the track costs problem can be fruitfully examined. Some of them have already been mentioned in the White Paper on Freight Transport, which refers to the contribution to policy which already it has made, through providing information on the most important inter-urban flows and on users' attitudes to transport. As the work advances, such contributions can be expected to grow.

121. To sum up, the Ministry has adopted an empirical approach to the problem of track costs which is aimed at allowing the implications of the various available policies to be examined. This approach is a difficult one and slow to mature, but it is ultimately the only fruitful one.

LIST OF ANNEXES

Page

1. Other work on Track Costs 41
2. The Ministry of Transport submission to the Geddes Committee... 44
3. Comments on "Road Revenues and Costs": a report by the Transport Holding Company 61
4. Comments on "A study of the Relative True Costs of Road and Rail Freight Transport over Trunk Routes," by the British Railways Board 62
5. The effect of charging for congestion on the pattern of charges ... 64
6. Regulations and prices: relative merits 68
7. Road pricing 70
8. The estimation of congestion costs 71
9. The attribution of road costs to non-road-users 73
10. The treatment of capital in road accounts 75
11. Rates as a road cost 81
12. The evaluation of accident costs and loss of amenity due to vehicle noise and fumes 82
13. The estimation of capital values for roads 88
14. Vehicle mile and vehicle fleet forecasts 90
15. Public road costs and the use of the roads by particular vehicle classes 93
16. Fuel tax, vehicle excise duties and purchase tax as charging mechanisms and some alternative charging methods 102
17. The long-run marginal cost of road provision 106
18. Data on axle-loadings 107
19. Theory of differentials between heavy goods vehicles 111

ANNEX 1

Other work on Track Costs

1. Although the subject of track costs has been controversial for a long time, it is only relatively recently that much empirical work has been done. Annexes 2–4 will refer to recent British contributions to the study of track costs. This will consider work done in other countries.

2. A great amount of research has been carried out in the United States, most of it resulting from a directive in the Highway Revenue Act of 1956. This Act required a Highway Cost Allocation Study to be carried out, which comprised the following studies:

> "(1) the effects on design, construction, and maintenance of Federal-aid highways of the use of vehicles of different dimensions, weights, and other specifications, and the frequency of occurrence of such vehicles in the traffic stream;
>
> (2) the proportionate share of the design, construction, and maintenance costs of the Federal-aid highways attributable to each class of person using such highways; and
>
> (3) any direct and indirect benefits occuring to any class, in addition to benefits from actual use of such highways, which are attributable to public expenditure for these highways".[1]

This work had to be co-ordinated with that being carried out by the Highway Research Board in co-operation with the Bureau of Public Roads at Ottawa, Illinois. The latter is generally known as the A.A.S.H.O.[2] road tests, and is the best known single piece of empirical work relating to the track costs problem.

3. "The A.A.S.H.O. road test at Ottawa, Illinois, was an entirely independent project from the Highway Cost Allocation Study. The use of its results in this study was only one of its important products, which included guidance in the design of pavements, both rigid and flexible, to meet the requirements of predicted axle-load conditions. Test vehicles having different axle loads, ranging from 2,000 pounds to 30,000 pounds for single-axle loads, and from 24,000 pounds to 48,000 pounds for tandem-axle loads, were operated on a virtually continuous schedule over test loops in which, for each axle load, there was a series of test sections, both rigid and flexible, varying in the dimensions of surface, base, and sub-base thickness (no base for rigid pavements). The results of these studies were productive of a series of models or equations expressing the relationships (within the limits of applicability of the test-road conditions) between the number of applications of a given axle load and the design characteristics of the pavement structure. Although each test loop was confined to the operation of vehicles with a given axle configuration and load, it was possible to convert the results to produce equations applicable to variations in the relative

---

[1] U.S. Department of Commerce, Highway Cost Allocation Study, Supplementary Report (89th Congress, 1st Session: House Document No. 124) U.S.G.P.O., 1965.

[2] American Association of State Highway Officials.

numbers of axle loads of different magnitudes."[1] The experiments suggested that to estimate the relative effect of different axle loadings, the weight of the axles should be raised to the fourth power. For reasons given in Annex 15, this power law almost certainly exaggerates the wear and tear effects of higher axle loadings in British conditions.

4. The associated work which the 1956 Act set under way is reported in the Final[2] and Supplementary Reports of the Highway Cost Allocation Study. Besides a wealth of information on studies relevant to highway cost allocation, they examine in detail the problems involved in applying four different approaches to the cost allocation problem: two of them similar to the cost responsibility approach and two of them similar to the benefit cost approach. The conclusions were similar to those of this Report, in that the benefit/cost approach was rejected, though for different reasons. The conclusions were as follows:

> "The differential-benefit study was experimental in character, and was indeed the first of its kind. In bringing to the fore the benefits of time savings and of the reductions in the strain and discomfort of non-uniform driving, this study introduced into the analysis the concept of demand—evidenced by willingness to pay taxes or tolls—as a measure or indicator of benefits anticipated. In so doing, it made possible the comparison called for in section 210—that between "costs occasioned" and "benefits derived" from the use of the highways as measures of relative highway cost responsibility.
>
> The defects of the differential-benefit study are those of a previously untried procedure. For example, the estimates of the unit value of time savings and of the strain and discomfort factor were based on a rather small number of observations on toll roads and their alternative free roads; and the results, although within the range of findings of previous work in this field, were of low statistical reliability. Similarly, estimates by the State highway department of the benefit-producing accomplishments of the projected Federal-Aid program—reductions in route lengths, reductions in rise and fall, inter-sections at grade and access points eliminated, etc.—could not be made accurately in the absence of plans from specific projects. It is thought, therefore, that the findings of the differential-benefit study should be used to supplement those of the incremental study and to delimit the range of possible allocation values. They should not replace the incremental findings: nor is there any clear reason for averaging the cost-allocation values given by the two methods."[3]

5. Thus the differential benefit approach is rejected because of doubts on the strength of the data not as in Chapter 7 because of conceptual difficulties over the appropriateness of the available measure of differential benefit to allocation of cost between vehicle groups. This issue was not raised in the study.

---

[1] U.S. Department of Commerce, Highway Cost Allocation Study Supplementary report (89th Congress, 1st Session: House Document No. 124), 1965, p.38.

[2] U.S. Department of Commerce, Highway Cost Allocation Study, final report (87th Congress, 1st Session: House Document No. 54), U.S.G.P.O., 1961.

[3] Highway Cost Allocation Study, supplementary report, pages 23–24.

6. The Reports contained little economic analysis and did not always adequately distinguish the aims and limitations of the allocation processes discussed. Since much of the factual material was irrelevant to British conditions, it is not possible to make useful comparisons of the conclusions in detail.

7. Work on track costs is currently under way at the present moment in Europe. As an aid to the development of the common transport policy, the Economic Commission of the Common Market has set under way major studies in each country of track costs for all forms of surface transport. The results of these studies are not yet publicly available. Already, however, a theoretical study, prepared at the request of the Economic Community, has been published[1]. This covers in more detail than has been possible in this Report the various charging principles that might be applied to transport, and concludes that short run marginal cost pricing is the most desirable.

8. Meanwhile, individual countries within the European Economic Community are conducting their own investigations. In Holland, for example, a Report on the "Costs of the Road Track"[2] prepared by a small study group within the Dutch Ministry of Transport, was published in 1956, and work is still in hand.

9. In France a special committee has been examining the problem of track costs, for road, rail and inland waterways, as a result of which proposals have been made for new taxes on heavy vehicles. The most interesting aspect of these proposals is that they relate not simply to the weight or capacity of the vehicle but also to the number of axles each has in relation to its prescribed capacity. The report of this committee is still confidential.[3]

---

[1] European Economic Community Studies: Transport Series No. 1, "Options in transport tariff policy" (Allais Report) E.E.C., 1965.

[2] Netherlands Ministry of Transport, Cost of the Road Track, First Report: The total costs and the total proceeds of taxes, Staatsuitgererij, The Hague, 1956.

[3] See, however, Annex 18.

ANNEX 2

This Annex reproduces the evidence offered in 1964 by the Ministry to the Committee on Carriers' Licensing.

Evidence by the Ministry of Transport to the Committee on Carriers' Licensing on the measurement and allocation of road costs

I INTRODUCTION

The Ministry understands that a number of organisations have either presented or intend to present material to the Committee on the subject of road costs and their allocation to different categories of road users. The Committee may therefore wish to have the results of a study of this subject on which the Ministry has been engaged for some time.

2. In carrying out its study, the Ministry has taken account of the extensive studies on infrastructure costs undertaken by the Economic Commission for Europe in Geneva, in which the United Kingdom has participated fully, and of the tests carried out by the Association of American State Highway Officials. In addition the Ministry has carried out its own investigations into some of the problems raised.

3. The present study is concerned only with the question of the measurement of road costs and of their allocation between different categories of vehicles. What should be included in costs and thus in the allocation of these costs will depend on the purposes of the calculation: for example, for many purposes a calculation of marginal costs would be appropriate. The Ministry would emphasise that it is extremely difficult to decide which costs should be brought to account and there is a wide difference of view between people interested in this matter on the method that should be adopted, particularly in determining the costs. The calculations made by the Ministry in this paper should therefore be regarded as tentative and experimental, although it is hoped they will be a useful contribution to the discussion.

4. There are other problems. It is not practicable to divide vehicles into classes according to all of their distinguishing characteristics—weight, annual mileage, usage of various types of road, and so forth—though they can reasonably be grouped by weight alone, which is probably the characteristic most significantly related to road costs. And the allocation of total costs between the vehicle categories which one can identify is inevitably approximate, since the requirements of the vehicles in the different categories are different but must be met on the same roads. Any allocations therefore necessarily involve a number of assumptions, which to some extent must be arbitrary. Where one single basis of cost allocation is not obviously the best, the Ministry has identified at least the two limiting bases between which it believes that the truth lies and has calculated for the alternatives. This paper attempts to state clearly the assumptions that have been made in this connection.

5. The Ministry's approach was as follows:

(i) a single year has been chosen and all calculations have been related to it—in practice 1962, the most recent year for which full statistics of road expenditure and vehicle traffic are available;

(ii) the costs of the road system in its entirety have been defined and measured;

(iii) in computing capital costs, two different methods—which it must be stressed are no more than illustrations of the possibilities—have been used: these are described in Section II;

(iv) these costs have been allocated amongst the categories of vehicles which the available information has made it possible to distinguish (see, for example, Tables 4–11).

6. The Ministry would like to make it clear that the results of its calculations are applicable only to 1962. Changes in the future in the pattern of traffic and possibly in the relationship between investment in roads and traffic volumes might produce different results for other years that might be chosen.

7. The Ministry is of course aware of the evidence submitted to the Committee by the British Railways Board under the title "A Study of the Relative True Costs of Freight Transport over Trunk Routes". The approach adopted in that study is, as the Committee will realise, entirely different from that adopted by the Ministry; so that whatever conclusions may be drawn from one study cannot be regarded as directly comparable with any drawn from the other.

II DEFINING AND MEASURING THE COSTS OF THE ROADS

General

8. In assessing the total costs of the road system, the Ministry has included the following items:

(*a*) Capital costs.

(*b*) Costs of maintaining and repairing the roads, and providing signs, signals and road markings.

(*c*) Costs of cleansing and snow clearing.

(*d*) Costs of lighting.

(*e*) Costs of accidents not covered by insurance.

(*f*) Costs of policing and traffic control.

(*g*) Costs of highway administration.

The division of road costs into the foregoing classes is used throughout this paper.

9. Throughout this study the Ministry has been concerned with expenditure by all public authorities, including local authorities as well as central government. It has accordingly not included in its definition of road costs for present purposes the social costs imposed by vehicle users on other members of the community through noise, fumes, dirt and so on for which the former are responsible. Nor has it included the special costs which arise in conditions of congestion. Not only are these vehicle-operating costs rather than road costs; but the greatest part of them is inflicted by vehicle users on each other rather than being borne, as are the costs listed in para. 8, by the community at large.

10. The Ministry would expect there to be general agreement that the costs in classes (*b*)-(*g*) (see para. 8 above) which occurred in 1962 should properly be included in total costs for 1962. There are points of detail about the size of these costs which are dealt with in paras. 17-19, but there are no issues of principle of the type which must be considered in relation to the capital costs of the roads.

Capital costs

11. Whether figures of total road costs should include an amount in respect of the capital costs of the existing road system is a question that arises whenever road costs are discussed. Some writers on the subject have suggested that a return on the replacement cost of the entire road system should be included; others that the return should be on the historic costs; others that road investment should be amortised over a particular number of years and accordingly that interest and amortisation charges should be taken on capital expenditure incurred during, say, the last 25 years; others have suggested that the value realised by road users from existing roads is relevant; the Salter Conference (1932) concluded that the cost of the existing road system attributable to vehicular traffic might be regarded as being cancelled out by the benefit from current expenditure on the roads to the community at large rather than to vehicle users. Everyone acknowledges the difficulty of producing actual figures with any conviction that they are even of the right general magnitude.

12. Of these various possibilities, the Ministry has selected as alternatives two quite different methods. Method I, which might be described as the "pay as you go method", charges against current traffic the capital costs actually incurred in the year of extending and improving the road system; and takes no specific account of the capital costs of the existing road system.

13. The other approach used implies treating the road system as though it were owned and managed by a public corporation which had obligations similar to those generally enjoined on the nationalised industries. This method (Method II) of producing a figure for the capital costs of the road system has been applied in the following way:

(i) by measuring the historical capital invested. The Ministry has done this by calculating the capital expenditure by public authorities on roads since 1909, because this study is concerned with the responsibilities of motor traffic for road costs and most expenditure before the advent of the motor vehicle and much (e.g. on many thousands of miles of estate roads) incurred since has been chiefly to meet requirements other than those directly related to motor traffic. On the other hand, motor traffic does derive benefit from the framework of the road system (including most of the land for it) which already existed in 1909;

(ii) by determining an appropriate return on the capital invested as so measured. Nationalised industries are expected to aim at a return on the historic cost valuation of their assets which covers, *inter alia*, interest, some provision for depreciation, and some contribution to reserve, available for financing future capital development or as a safeguard against premature obsolescence. Targets have been set for a number of nationalised industries with these aims in view, although the wide differences in the economic conditions of the various undertakings have meant that it has not been appropriate to apply a single standard formula. A further important consideration is that nationalised industries should earn an adequate return on new investment. In the case of roads there is, in general, a very large difference between the historic cost of a road and the cost of building new roads or making major improvements to old roads. This distinguishes roads in degree from many other industries where the difference between the historic and replacement cost of plant and machinery is not so great. Thus, in order to get an adequate return on the considerable amount of new investment in roads currently being undertaken, the return ought perhaps to be considerably higher than required to yield only as much on the historic cost of its assets as is aimed at by the more profitable nationalised industries. Nevertheless for the purposes of the calculations in this paper a gross rate of return of 10 per cent on historic cost as calculated above has been taken. This compares, for example, with a gross return of 12.4 per cent which has been set as the target for the England and Wales Electricity Boards and a net return of 8 per cent which has been set for the Post Office.

14. It can reasonably be argued that under Method II the body postulated as owning the roads should be regarded as liable to pay local rates on the roads. Any attempt to calculate rates in this context involves many doubtful assumptions; and, while the Ministry has noted that A. R. Prest in "Some aspects of road finance in the U.K." (Journal of the Manchester School of Economic and Social Studies, September 1963) has produced, by what he calls "extremely rough calculations" a notional figure of £40m. per annum for rates, it would not wish either to endorse this figure or to offer any other figure of its own. Accordingly, rates have been omitted from these calculations; this omission means that (if the argument stated above is accepted) costs on Method II are in this respect understated.

15. The Ministry has included in "capital costs" the costs of "minor improvements". "Minor improvements" is not a precise term, and to some extent the nature of work so described has changed over the years. While at one time work consisting predominantly of improvements to the road surface, kerbs and drainage effectively made up the scope of "minor improvements", today this class of expenditure is directed chiefly to small-scale widening of roads, to straightening of bends, etc. Thus minor improvements were once closely akin to maintenance, while today expenditure on them can be regarded as adding to the "capital stock" of the roads. The Ministry has not thought it practicable to distinguish different types of minor improvement work but, while recognising that this assumption will result in an over-estimate, has included all minor improvements in "capital costs". There are three points of detail on minor improvements:

(*a*) the split of maintenance and minor improvement expenditure on trunk and classified roads in 1962 into maintenance on the one hand and minor improvements on the other has been studied and assessed by the Ministry's engineers;

(*b*) in the case of unclassified roads no reliable split has yet been made of maintenance and minor improvement expenditure: the Ministry has therefore made such a split for the purpose of this study by assuming that the relative proportions of the elements in the total of maintenance and minor improvement expenditure are the same for unclassified roads as they are for Class III roads, i.e. the most similar class of roads for which an assessment has been made;

(*c*) for the years 1938–1961 inclusive no firm figures are available for the split between maintenance and minor improvements, nor for the years before 1938 for the split between maintenance, minor improvements, cleansing and administration. To obtain minor improvement figures for these years the Ministry has assumed that minor improvement expenditure was proportionately the same throughout as the Ministry's assessment has shown it to be in 1962. This again will tend to overestimate the "capital costs".

16. On the foregoing bases the figures included in the calculations for capital costs for 1962 are:

On Method I £152m.
On Method II 10 per cent of £1,450m. = £145m.

Explanatory comment on "E—Lighting"

17. The part of the total lighting costs attributable to vehicle traffic has been taken as that incurred on trunk roads by the Ministry of Transport and local authorities and on classified roads by county boroughs, on the assumption that the expenditure by all other authorities is incurred mainly for the benefit of ratepayers.

Explanatory comment on "F—Costs of Accidents not covered by insurance"

18. The appropriate figure to include in the calculations in respect of accidents would be the charge falling on public funds, mainly the National Health Service. There is no easy means of determining this figure. It would, however, represent a large part of the difference between the estimated total costs caused by accidents and the amounts paid by insurance companies in meeting accident claims. The total difference has been used: it is clearly an overestimate, but not such as to make a significant difference to the final results. Total costs of accidents are estimated in accordance with the principles described by D. J. Reynolds "The Cost of Road Accidents" (Journal of the Royal Statistical Society, Vol. 119, Part 4 (1956)), the original estimates being kept up-to-date by the Road Research Laboratory. Figures of the amounts paid by insurance companies are also compiled by the Road Research Laboratory.

Explanatory comment on "G—Policing and Traffic Control"

19. The costs of traffic control have been taken as one-third of the costs of the country's police forces (following A. R. Prest, op. cit.).

Total costs

20. Total road costs for 1962 according to the foregoing definitions are set out below:—

TABLE 1

Total road costs in 1962 analysed by classes of cost

	£ millions	
Cost class	*Method I*	*Method II*
(A) Capital costs	152	145
(B) Maintenance and repair, etc.	72	72
(C) Cleansing and snow clearing	31	31
(D) Lighting	7	7
(E) Costs of road accidents not covered by insurance ...	7	7
(F) Policing	57	57
(G) Highway administration	22	22
Total	348	341

III ALLOCATION OF COSTS

General

21. The following paragraphs deal successively with the classes of road costs distinguished in paragraph 8 above. In relation to each class of costs the principles and methods adopted by the Ministry are described and the results given of the calculations that have been made. Some general points, however, need discussion first.

22. Greater accuracy in allocation could, in theory, be achieved by dealing successively with each class of road (namely Trunk, Class I, Class II, Class III and Unclassified): taking the costs of each according to the classes of cost listed in paragraph 8 and the usage of each by each category of vehicles. Tables 2 and 2A show the significant differences in the proportions within total traffic of various types of goods vehicles on the different classes of road.

TABLE 2

Goods Vehicles: estimated proportion of total road traffic

Percentages

Type of goods vehicles by number of axles	*Type of road* *Trunk*	*Class I*	*Class II*	*Class III*	*Unclassified*
Light van	10	12	14	15	18
Other, 2 axles	15	11	10	9	9
Other, 3 or more axles ...	5	2	1	2	—
All goods vehicles	30	25	25	26	27

Source: Road Research Laboratory, "Sample Survey of the Roads of Great Britain".

TABLE 2A

Goods Vehicles: estimated proportion of total road traffic

Percentages

Type of goods vehicles by unladen weight		*Type of road* *Trunk*	*Class I*	*Class II*	*Class III*	*Unclassified*
Over	**Not over**					
—	1½ tons	10	12	14	15	18
1½ tons	3 tons	3	3	5	5	7
3 tons	—	17	10	6	6	2
All goods vehicles		30	25	25	26	27

Source: Estimates based on data in Table 2 above.

23. Similarly, Table 3 shows the breakdown of expenditure by classes of road.

TABLE 3

Road costs in 1962 analysed by classes of cost and types of road

£ millions

Cost class	Trunk	Type of road Classified I	II	III	Unclassified	All roads
(A) Capital costs:						
Method I	75	47	8	7	15	152
Method II[1]	—	—	—	—	—	145
(B) Maintenance and repair, etc.	8	14	8	15	27	72
(C) Cleansing and snow clearing[2]	2	16	4	5	4	31
(D) Lighting[3]	1	2	2	2	—	7
(E) Costs of accidents not covered by insurance[4]	1	3	1	1	1	7
(F) Policing[4]	11	27	6	7	6	57
(G) Highway adminstration[5] ...	4	2	2	5	9	22
Sub-total of classes (B)–(G) ...	27	64	23	35	47	196
Total including (A) Method I figure	102	111	31	42	62	348
Total including (A) Method II figure[1]	—	—	—	—	—	341

1. Breakdown by type of road not possible on this method (see paragraph 24).
2. Allocation between classified and unclassified roads is according to share in total traffic on these roads.
3. Allocation between classified roads is according to road mileage in urban areas.
4. Allocation between all types of road is according to share in total traffic.
5. Allocation between classified and unclassified roads is according to road mileage.

24. These tables taken together suggest that the allocation of all expenditure without distinction between classes of road would be inequitable to the heavier vehicles, particularly because of the substantial expenditure on unclassified roads for which goods vehicles generally cannot reasonably be held to have any significant responsibility. The Ministry has therefore thought it would be a fair compromise between this and dealing with each class of road separately to take out the expenditure on unclassified roads and allocate this between cars, light vans and motor cycles on a "passenger car unit-mileage" basis (whereby a motor cycle is taken as the equivalent to half a car or light van). However, in relation to cost class (A) "capital costs", it would effectively be impossible to separate throughout the years from 1909 investment in unclassified roads from investment in other roads. No attempt has therefore been made to deal separately with investment expenditure on unclassified roads either on the Method I or the Method II approach to capital costs, but all other expenditure on unclassified roads has been dealt with separately. Accordingly: (*a*) the discussion of cost class (A) (paras. 27–32) relates to the cost of all roads, (*b*) the discussion of cost classes B–G (in paras. 33–41) relates to trunk, class I, class II and class III roads as a block; (*c*) unclassified road costs in classes B–G are treated in para. 42.

25. The available information makes it possible to divide goods vehicles by weight into seven groups, all vehicles having an unladen weight of more than 8 tons falling in one group. The Ministry has divided goods vehicles into categories accordingly. It should perhaps be noted here that the correlation between vehicles' unladen weight and their axle loadings throughout the range of both is not particularly close.

26. The Ministry also wishes to comment on the A.A.S.H.O. Tests. These tests were carried out under the auspices of the Association of American State Highway Officials in the United States at a cost understood to be of the order of $27m. with the aim of establishing the number of applications of various loaded axle-weights that roads built to different standards could carry before they deteriorated to the point of unserviceability; and, accordingly, to what specifications road pavements (or carriageways) must be built to serve the needs of various weights of vehicles. From these tests have been derived formulae (not by A.A.S.H.O. themselves) relating the costs incurred in constructing and renewing carriageways to the laden axle-weights of the vehicles using them. The Ministry has some doubt about the reliance that should be placed on these findings for the purpose of road cost allocations, endorsing the comments made by the Director of Road Research at a meeting of the Institution of Civil Engineers held to discuss the tests. The Director said:

> "Although it is of the utmost importance that the conclusions from this very large experiment should be utilised to the full in Great Britain, it is essential first to consider the results carefully in relation to British conditions. A major factor is the influence which frost had on the performance of the flexible pavements. The fact that 57 per cent of the failures occurred in the first spring thaw and 23 per cent in the second shows that the pavements were critically weak during those periods. So far as the heavy axle loads are concerned, the A.A.S.H.O. experiment was an accelerated test, the concentration of axle loading being 5–10 times that which will be present on a normal heavily trafficked British road. It is possible that many sections failed which would have survived the normal traffic concentration of a highway. This seems to be a basic weakness of the test and the method of weighting the applications of axle load used in the analysis does not appear to overcome the difficulty."

Nonetheless, to the extent indicated below in consideration of costs in classes A and B, the Ministry has made use of the A.A.S.H.O. findings in some of its calculations.

(A) Capital costs—(1) on Method I ("pay as you go")

27. Capital costs computed according to Method I (see para. 12 above) may be said to be incurred:

(*a*) to improve the constructional standards of existing roads; and

(*b*) to increase the capacity of the road system. This involves enlarging existing roads and constructing new roads of a size and strength adequate to withstand expected usage of the roads by the expected quantity of mixed traffic.

The logical distinction between these types of capital costs is that in theory the allocation of costs of increasing the capacity of the road system should take account of where responsibility for the need for greater capacity truly rests. This could never be an easy question even with the fullest information about existing traffic and the best predictions of future traffic in relation to a particular road. In general there is evidence from traffic censuses to show that, while the flow of goods traffic through the year—and indeed on the trunk routes through the 24-hour day—is relatively steady, private cars have chief responsibility for traffic peaks; and accordingly it could be argued that the costs of investment for the purpose of increasing capacity should be allocated mainly to them. The Ministry has not, however, attempted to examine the possible split between the two objectives of capital investment stated above, but has treated all capital investment alike and allocated its costs between categories of vehicles on engineering considerations.

28. The first step in the allocation of capital costs has been to establish, to the limits of possible accuracy, the part of total construction costs which can be ascribed to the need to cater for the special demands of heavy vehicles. This can best be done by subtracting from the costs of a road built to a standard suitable for mixed traffic the costs of a road suitable for use by light vehicles only. No actual roads of the latter type are built and the relevant costs can be obtained only from theoretical calculations. Such calculations have been done by the Ministry's highway engineers to establish the saving potentially possible from constructing a motorway for the use of light vehicles (i.e. vehicles of less than 1½ tons unladen weight). These calculations, which are described in the Appendix indicate that the saving on these assumptions is approximately 17½ per cent of total costs. The Ministry estimates that the corresponding saving on the construction and minor improvement of other types of road would be no greater than this, and so it has taken the part of total costs which can be ascribed entirely to heavy vehicles as 17½ per cent.

29. This part of capital costs has therefore been ascribed exclusively to heavy vehicles (i.e. vehicles of more than 1½ tons unladen weight) and allocated amongst the categories of heavy vehicles which this paper distinguishes (within the 1 ton–2 ton category half the vehicles have been assumed to weigh more than 1½ tons). For the purpose of this allocation the Ministry has used two alternative bases, namely:

(i) allocate costs in proportion to the gross-ton-miles performed by the different categories of vehicles; or

(ii) rely on the indications from the results of the A.A.S.H.O. Tests that the increases in constructional standards necessary if carriageways are to withstand the passage of heavier vehicles are proportional to axle-weight ratio raised to the power of two-thirds.

30. This leaves a balance of investment costs amounting to 82½ per cent of the total to be allocated amongst all vehicles. These costs have been allocated on a basis of p.c.u.-mileages. The significance of p.c.u.'s (passenger car units) in this connection is that they are generally accepted as a measure of the space occupied by, and the effect on traffic flow of, different types of vehicle. The p.c.u. measure classes together all heavy vehicles as the equivalent of three private cars.

31. Allocating total investment costs in accordance with paragraphs 29 and 30 above gives the results in Table 4 which follows. Here columns and 1 and 2 show the effects of the alternative procedures described in paragraph 29 and columns 4 and 5 give the sums of columns 1 and 3 and columns 2 and 3 respectively. It will be seen that the two procedures give very similar results.

TABLE 4

Capital costs computed according to Method I allocated to categories of vehicles

£ millions

Category of vehicle	(*1*) *Costs ascribed exclusively to heavy vehicles* *Allocated on basis of gross-ton-miles*	(*2*) *Costs ascribed exclusively to heavy vehicles* *Allocated on basis of estimated axle-weight raised to power of two-thirds*	(*3*) *Balance of costs allocated between all vehicles on a basis of p.c.u. miles*	(*4*) *Total colums 1 and 3*	(*5*) *Total colums 2 and 3*
Cars and taxis ..	—	—	62·5	62·5	62·5
Motor cycles ..	—	—	3·4	3·4	3·4
Buses and coaches	4·4	3·8	9·4	13·8	13·2
Goods vehicles					
Over *Not Over*					
— 1 ton ..	—	—	7·5	7·5	7·5
1 ton 2 tons ..	0·9	0·7	4·6	5·5	5·3
2 tons 2½ tons	0·7	0·8	2·6	3·3	3·4
2½ tons 3 tons	2·6	3·1	7·4	10·0	10·5
3 tons 5 tons	10·9	11·1	20·1	31·0	31·2
5 tons 8 tons	4·8	5·1	6·0	10·8	11·1
8 tons —	2·3	2·0	1·9	4·2	3·9
Total goods ..	22·2	22·8	50·1	72·3	72·9
Total	26·6	26·6	125·4	152·0	152·0

(A) **Capital costs—(2) on Method II ("capital invested")**

32. The allocation of capital costs determined according to Method II (see para. 13 above) presents a conceptual problem. Costs associated with capital invested in the past cannot be said to be due to the requirements of particular categories of vehicles today, nor can it be assumed that the relative responsibilities that can be attached to the different types of vehicles for the constructional standards adopted today hold good equally for the past. There is, therefore, no wholly satisfactory way of making the allocation and, in the absence of any better method, the Ministry considers that the capital costs computed by Method II might be allocated in accordance with the principles described in paras. 29 and 30 above. Since the total for allocation is, as para. 16 above shows, closely similar to the total according to Method I, a separate calculation related to Method II capital costs is not shown.

(B) Maintenance and Repair Costs, including Costs of Providing Signs, Signals and Road Markings:

33. The class of costs described as "maintenance and repair costs" includes outlays for a variety of purposes for which the relative responsibilities of different categories of vehicles are likely to differ markedly. Since cleansing and snow clearing already appear separately (cost class (C)), it is probably sufficient to distinguish work into these elements:

(i) repair;

(ii) preventive maintenance of the road surface, i.e. maintenance to keep the running surface in good order and prevent the need for actual repair;

(iii) miscellaneous work on drainage, kerb renewal, etc.

(iv) provision of signs, signals and road markings.

Against present knowledge about division of maintenance and repair expenditure between different objectives any attempt at further breakdown would be unrealistic.

34. On the allocation of (i) repair costs, the A.A.S.H.O. Tests tend to show that relative responsibility increases in proportion to the fourth power of the increase in the laden axle-weight of vehicles. Application of a cost allocation formula based on this finding inescapably means the allocation to heavy vehicles of almost all repair costs.

35. The Ministry is unaware of any authoritative study of the relative responsibility of different categories of vehicles for wear to the surface of the road and hence for (ii) the costs involved in preventive maintenance of it. But it considers that the closest relationship is probably to be found between surface wear and the weight applied to the surface, and accordingly it has allocated these costs on the basis of gross-ton-miles.

36. The Ministry considers that (iii) the costs of miscellaneous maintenance work and (iv) the costs of providing signs, signals and road markings can most reasonably be allocated on the basis of vehicle-miles.

37. It is now necessary to state to what parts of total maintenance and repair costs each of the allocation procedures described in the preceding paragraphs has been applied. Essentially the Ministry has taken what it considers to be reasonable assumptions: no precise split of maintenance and repair costs has ever been made. But these assumptions do take account of modern engineering practice, which is towards preventive maintenance. Normally nowadays maintenance does not take the form of repair to roads which have become unserviceable under the impact of traffic, but rather is carried out before serious damage occurs, often on a scale which raises the bearing qualities of a road to a standard which ensures only minimal deterioration in expected traffic conditions. In present conditions the Ministry is satisfied that the part of maintenance and repair costs incurred in making good roads seriously damaged to the point where they need repair cannot exceed 25 per cent. This percentage has therefore been incorporated in one set of assumptions, while another set includes a lower

(and probably more realistic) figure for repair of 10 per cent. Miscellaneous maintenance and the costs of providing signs, signals and road markings have been taken as alternatively 40 per cent and 25 per cent; and preventive maintenance in each case as 50 per cent. On a combination of extreme assumptions, the two complete sets of assumptions about the appropriate split in the total costs of maintenance, etc. are thus (figures are percentages):

	Assumption No. 1	*Assumption No. 2*
Repair	25	10
Preventive maintenance	50	50
Miscellaneous and Signs, etc. ...	25	40

38. Allocations between categories of vehicles on the foregoing assumptions give the results in the following Table.

TABLE 5

Maintenance and repair costs on trunk and classified roads allocated to categories of vehicles

Category of vehicle		(*1*) *Allocation on basis of assumption No. 1 (see para. 3F)*		(*2*) *Allocation on basis of assumption (No. 2 (see para. 3F)*	
Cars and taxis			14·3		18·5
Motor cycles			0·9		1·4
Buses and coaches ...			2·7		3·0
Goods vehicles					
Over	*Not over*				
—	1 ton ...	1·6		2·1	
1 ton	2 tons ...	1·5		1·8	
2 tons	2½ tons ...	0·5		0·5	
2½ tons	3 tons ...	1·8		1·9	
3 tons	5 tons ...	7·9		7·6	
5 tons	8 tons ...	8·5		5·2	
8 tons	— ...	5·3		3·0	
	Total goods ...		27·1		22·1
	Total ...		45·0		45·0

It will be seen that column 1 gives an allocation less favourable to heavier vehicles and column 2 an allocation more favourable to heavier vehicles.

(C–E) Costs of Cleansing and Snow Clearing; of Lighting; and of Accidents not covered by Insurance

39. The Ministry considers that the appropriate basis for allocating these costs is in accordance with vehicle-miles. The following Table shows the results of these calculations.

TABLE 6

Costs on trunk and classified roads of cleansing; of lighting; and of accidents not covered by insurance allocated to categories of vehicles

£ millions

Category of vehicle			*Cleansing and snow clearing costs*	*Lighting costs*	*Cost of accidents not covered by insurance*	*Total*
Cars and taxis			17·3	4·5	3·9	25·7
Motor cycles			1·9	0·5	0·4	2·8
Buses and coaches			0·9	0·2	0·2	1·3
Goods vehicles	*Over*	*Not over*				
	—	1 ton	2·1	0·6	0·5	3·2
	1 ton	2 tons	1·3	0·3	0·2	1·8
	2 tons	2½ tons... ...	0·2	0·1	0·1	0·4
	2½ tons	3 tons ...	0·7	0·2	0·2	1·1
	3 tons	5 tons ...	1·9	0·5	0·4	2·8
	5 tons	8 tons	0·5	0·1	0·1	0·7
	8 tons	—	0·2	—	—	0·2
Total goods ...			6·9	1·8	1·5	10·2
Total			27·0	7·0	6·0	40·0

(F) **Policing and Traffic Control Costs**

40. Inasmuch as the need for traffic control results from traffic flow and the accepted measure of contribution to traffic flow is p.c.u's, there is a strong case for allocating these costs according to p.c.u.-miles. But it may also be argued that they should be allocated simply according to vehicle-miles, and calculations on both bases are shown in the following Table.

TABLE 7

Policing and traffic control costs on trunk and classified roads allocated to categories of vehicles

£ millions

Category of vehicle			(1) *allocation on basis of p.c.u. miles*	(2) *allocation on basis of vehicle miles*
Cars and taxis			25·3	32·8
Motor cycles			1·4	3·5
Buses and Coaches ...			3·8	1·6
Goods vehicles	*Over*	*Not over*		
	—	1 ton ...	3·1	4·0
	1 ton	2 tons ...	1·9	2·4
	2 tons	2½ tons ...	1·1	0·5
	2½ tons	3 tons ...	3·0	1·3
	3 tons	5 tons ...	8·2	3·6
	5 tons	8 tons ...	2·4	1·0
	8 tons	—	0·8	0·3
Total goods ...			20·5	13·1
Total			51·0	51·0

It will be seen that column 1 gives an allocation less favourable to heavier vehicles and column 2 an allocation more favourable to heavier vehicles.

(G) **Costs of Highway Administration**

41. In general, administration costs should be allocated on the same basis as the costs of the road works and services with which they are associated. The simplest method of achieving the right allocation between categories of vehicles would seem to be to sum all costs for each category of vehicle and allocate administration costs proportionately to these totals. The amounts under the heading of administration are not, however, large and in practice in

arriving at the single set of figures in the Table which follows, the Ministry has taken the average of the extremes of costs which may, as shown in Tables 4–7 above, be allocated on alternative assumptions to different categories of vehicles.

TABLE 8

Administration costs on trunk and classified roads allocated to categories of vehicles

Category of vehicle		£ millions	
Cars and taxis		—	6·1
Motor cycles		—	0·5
Buses and coaches ...		—	0·9
Goods vehicles			
Over	*Not over*		
—	1 ton ...	0·7	—
1 ton	2 tons ...	0·5	—
2 tons	2½ tons ...	0·2	—
2½ tons	3 tons ...	0·7	—
3 tons	5 tons ...	2·1	—
5 tons	8 tons ...	0·9	—
8 tons	—	0·4	
	Total goods ...	—	5·5
	Total ...	—	13·0

Expenditure on Unclassified Roads

42. As explained in paragraph 24 above, the Ministry has calculated separately the allocation of expenditure (other than expenditure on capital account) on unclassified roads between light vans, private cars and motorcycles. The results are as follows:

TABLE 9

Expenditure on unclassified roads (excluding expenditure on capital account) allocated between cars, motor cycles and light vans

Category of vehicle		£ millions	
Cars and taxis		—	37·7
Motor cycles		—	1·9
Goods vehicles			
Over	*Not over*		
—	1 ton ...	4·6	—
1 ton	2 tons ...	2·8	—
	Total goods ...	—	7·4
	Total ...	—	47·0

43. The figures in Tables 4–9 above may of course be combined in a variety of ways. But, as indicated in para. 4 above, the Ministry has thought it would be instructive to see the effects of summing on the one hand those figures which combine to produce a less favourable picture for the heavier vehicles and on the other those which combine to produce a more favourable picture. These results appear in Tables 10 and 11 respectively. Both Tables include capital costs computed according to Method I (see para. 12 above) only; but as para. 16 above shows, the results that would be obtained with the inclusion of Method II capital costs would be only marginally different and they have therefore not been separately calculated.

Ministry of Transport,
London, S.E.1.
August, 1964.

TABLE 10

Total road costs (including capital costs computed according to Method I) allocated to categories of vehicles on bases producing a less favourable picture for the heavier vehicles

£ millions

			Cost Class				
	(A)	*(B)*	*(C–E)*	*(F)*	*(G)*		
Category of vehicle	*Capital Costs*	*Maintenance, etc.*	*Cleansing, etc. lighting; accidents*	*Policing*	*Adminis-tration*	*Unclassified roads (excluding expenditure on capital account)*	*Total*
	(Table 4 Col 4)	*(Table 5 Cal. 1)*	*(Table 6)*	*(Table 7 cal. 1)*	*(Table 8)*	*(Table 9)*	
Cars and taxis	62·5	14·3	25·7	25·3	6·1	37·7	171·6
Motor cycles	3·4	0·9	2·8	1·4	0·5	1·9	10·9
Buses and coaches	13·8	2·7	1·3	3·8	0·9	—	22·5
Goods vehicles							
Over *Not over*							
— 1 ton	7·5	1·6	3·2	3·1	0·7	4·6	20·7
1 ton 2 tons	5·5	1·5	1·8	1·9	0·5	2·8	14·0
2 tons 2½ tons	3·3	0·5	0·4	1·1	0·2	—	5·5
2½ tons 3 tons	10·0	1·8	1·1	3·0	0·7	—	16·6
3 tons 5 tons	31·0	7·9	2·8	8·2	2·1	—	52·0
5 tons 8 tons	10·8	8·5	0·7	2·4	0·9	—	23·3
8 tons —	4·2	5·3	0·2	0·8	0·4	—	10·9
Total goods	72·3	27·1	10·2	20·5	5·5	7·4	143·0
Total	152·0	45·0	40·0	51·0	13·0	47·0	348·0

TABLE 11

Total road costs (including capital costs computed according to Method I allocated to categories of vehicles on bases producing a more favourable picture for the heavier vehicles

£ millions

Categary af vehicles		(A) Capital Casts (Table 4 Cal. 5)	(B) Maintenance, etc. (Table 5 Col. 2)	Cast Class (C–E) Cleansing, etc. lighting; accidents (Table 6)	(F) Policing (Table 7 Cal. 2)	(G) Adminis-tration (Table 8)	Unclassified roads (excluding expenditure an capital accaunt (Table 9)	Total
Cars and taxis ...	...	62·5	18·5	25·7	32·8	6·1	37·7	183·3
Motor cycles ...	...	3·4	1·4	2·8	3·5	0·5	1·9	13·5
Buses and coaches ...	...	13·2	3·0	1·3	1·6	0·9	—	20·0
Goods vehicles								
Over	*Nat aver*							
—	1 ton ...	... 7·5	2·1	3·2	4·0	0·7	4·6	22·1
1 ton	2 tons ...	... 5·3	1·8	1·8	2·4	0·5	2·8	14·6
2 tons	2½ tons ...	... 3·4	0·5	0·4	0·5	0·2	—	5·0
2½ tons	3 tons ...	... 10·5	1·9	1·1	1·3	0·7	—	15·5
3 tons	5 tons ...	... 31·2	7·6	2·8	3·6	2·1	—	47·3
5 tons	8 tons ...	... 11·1	5·2	0·7	1·0	0·9	—	18·9
8 tons	— ...	... 3·9	3·0	0·2	0·3	0·4	—	7·8
Total goods ...	...	72·9	22·1	10·2	13·1	5·5	7·4	131·2
Total ...	...	152·0	45·0	40·0	51·0	13·0	47·0	348·0

Comments by the Ministry of Transport's Highways Engineering Department on the Savings in Construction Costs obtained from building a Motorway to carry Light Vehicles only

1. Engineers of the Ministry of Transport have examined the hypothetical possibility of building a motorway for the carriage exclusively of vehicles of 30 cwt. maximum unladen weight. They have assumed:

(*a*) that lane widths would remain at 12 feet to accommodate high-speed vehicles;
(*b*) that hard shoulders, verges and medians should be built to the same dimensions as for a general-purpose motorway;
(*c*) that adequate headroom clearance at bridges would be 9 feet.

2. They judge that any increase in speed which might be realised on a road from which heavy vehicles were excluded would not necessitate any increase in constructional standards or costs. Most of the increase in the mean speed of vehicles would occur as a result of faster travel at the lower ranges of speed rather than at the higher, so that the top design speed could remain unaltered. To increase it by, say, 5 miles per hour would not in any case produce any significant increase in cost.

3. They calculate that savings could be made as follows (all figures per mile):

(i) on structures—£50,000;
(ii) because of the reduced clearance on road bridges, in earthworks, drainage and land costs on both the motorway and the side roads—about £25,000;
(iii) on earthworks designed to moderate gradients—£4,000 per mile. With no heavy vehicles somewhat steeper gradients could be used, though the effect would vary considerably with topography and geology, and also with the scope available in route selection, especially in hilly areas. On a typical length of motorway the limiting factor in profile design might well be the attainment of adequate forward visibility on summit curves, and the levels of railways, rivers and roads to be crossed, rather than maximum gradients. But, overall acceptance of a 5 per cent desirable maximum grade with an increase to an absolute maximum of 6 per cent would produce the saving estimated;
(iv) from modifications in pavement design—about £45,000. The lowest-strength category pavements have a total thickness of only 2 in. less than that of the highest category in order to allow for frost action, but they are composed of cheaper materials. This would apply also to the hard shoulders. On the motorway carriageways a strong rugous and impervious running surface would still be required, i.e. hot rolled asphalt as at present, to deal with the intensity and speed of traffic.

4. Total obtainable savings would thus be of the order of £124,000 per mile. This is 17½ per cent of the average cost of motorway construction (£700,000 per mile).

ANNEX 3

Comments on "Road Revenues and Costs"

A Report by the Transport Holding Company[1]

1. The approach to the road track cost problem adopted by the Transport Holding Company in "Road Revenues and Costs" which was presented to the Geddes Committees was similar to some of the approaches looked at in the present Report. An attempt was made, for example, to draw up a balance sheet for the road system which produced, as do the figures in this report, (chapter 5) a surplus of revenue over public costs. A number of methods were explored of putting the road system on a commercial, or public enterprise, basis. A large number of ways of treating capital were examined and the appropriate charges and yield on capital value estimated. None of these altered the conclusion that the roads considered in this way were running a surplus.

2. In one important way, however, the T.H.C. report differs from this Report. It was argued that if what have been termed community costs in this Report are brought into the reckoning, then community benefits should also be brought in. The argument, as it is put in the Report, is fallacious because it involves double counting[2].

3. The benefits mentioned in the T.H.C. report, e.g. the fact that the flexibility that road transport offers allows new patterns of manufacturing, stockholding, distribution and choice of location, together with the "gain" experienced on leisure activities made possible by road transport, are benefits accruing through road use. The benefits received by road users are measured in benefit calculations by estimating savings in vehicle operating costs, time and accidents which result from new roads and road improvements. It is principally savings in time which make rescheduling possible and it is the ability to reschedule that permits new patterns of manufacturing, stockholding and distribution and choice of locations. Thus to value time savings and these other benefits would be double counting. In any case, however greater the benefits accruing from road use are than the costs of providing roads, it by no means follows that these costs should not be met by road users. A surplus of benefits over costs, however great, simply means that overall the current commitment of resources to roads is justified.

4. It is not, of course, double counting to estimate the benefits that accrue directly to non-road users, e.g. the rights of way enjoyed by statutory undertakings and to argue that these should be set against the costs of providing roads. This question is discussed in Annex 9.

---

[1] Transport Holding Company "Road Revenues and Costs" memorandum to the Committee on Carriers' Licensing (Geddes Committee), T.H.C., 1964.

[2] Cf. paras 55–56.

ANNEX 4

Comments on "A Study of the Relative True Costs of Rail and Road Freight Transport over Trunk Routes" by the British Railways Board[1]

1. The approach adopted in this study, also presented to the Geddes Committee, was abstract: it did not look at actual costs incurred at the time when the Study was written, but examined a hyphothetical "cost/operational model in respect of the provision and maintenance of rail and road trunk routes and the operations over such routes". This model compares road and rail costs and led to the conclusion that large freight road vehicles were not currently paying their share of track costs. The model can be criticised both factually and theoretically.

2. The main factual criticism concerns the Study's assumption that over 70 per cent of the cost of building a high capacity road would be saved if it did not need to be designed for heavy vehicles. This view which is examined in Annex 15 has received no support and it would appear unjustifiable. While this is by far the most important criticism, the treatment of a number of other items may nevertheless be challenged.

3. It is not clear, for example, precisely how those maintenance costs which are solely attributable to heavy vehicles were calculated as there is no obvious way in which they could be derived by the statistical analysis referred to on page 19 of the Study. In fact, on the type of road under consideration, the proportion of total maintenance costs attributable solely to heavy goods vehicles is very small, since work on the surface is a very small proportion of total annual costs. The use of the A.A.S.H.O. results for high capacity roads might also be questioned, as there are strong reasons for thinking that the A.A.S.H.O. results are too severe on heavy vehicles in British conditions. This is further discussed in Annex 15. However, once it is accepted that repairs to the surface form a small portion of total cost, this second point takes on much less importance, since it is only the combination of high repair costs *and* a relationship of the A.A.S.H.O. kind which allocates a high proportion of total maintenance costs to heavy vehicles.

4. Further, there would seem no good ground to attribute, as the Study does, those costs which are unrelated to vehicle weight—certain construction and maintenance costs, snow clearing, road cleansing, police and lighting—on the basis of the different amount of road space each vehicle may be said to occupy. As the discussion of these cost items in Annex 15 indicates, there can be no case in terms of extra costs caused for attributing more of these costs per vehicle mile to the heavier vehicle. If, then, there is no cost basis for the attribution, the allocation method is essentially one of equity not of economics (cf. chapter 8 of the Report), and the reasons advanced in the Notes to the Tables to that chapter may be adduced in support of lower figures. Apart from these points, certain parts of the Study were handicapped by data deficiencies, particularly maintenance and policing costs for high capacity roads. The Railways Board, however, used the best available information at the time.

---

[1] British Railways Board, "A Study of the Relative True Costs of Rail and Road Freight Transport over Trunk Routes," memorandum to the Committee on Carriers' Licensing (Geddes Committee), B.R.B., 1964.

6. The major theoretical attraction of the Board's Study is that it looks at future, and not at past costs. It is a long run marginal cost pricing approach (see Chapter 5.). But although this view has considerable economic support there are difficulties in applying it to roads. As Annex 17 argues, current capital expenditure on the system as a whole is the best approximation to long run marginal costs that it is possible now to achieve. An implicit assumption of the Board's approach is that it is possible to isolate the trunk road system for charging purposes and charge for it separately, but with current methods it is impossible to discrimate between one route and another. Consequently any charge that was right for the type of route examined by the Study would have to be levied generally, which, because little investment is done off the main routes, would lead to a capital charge very much higher than what was actually being invested on the road network as a whole.

7. A further implicit assumption is that the cost of providing extra capacity on motorways and dual carriageways is representative of the main trunk system. But although already some sections of motorway are being used beyond their design capacity there are nevertheless large parts—in terms of mileage—of the trunk system which do not need investment of the type proposed. In the period over which road investment capital might be written off, none may be needed on some stretches and therefore long run marginal cost may be accounted zero since no extra capital is needed to allow production to continue. Finally, the Board's Study did not acknowledge the possibility that at the charges proposed, heavy vehicles would not wish to use the new facilities—in this they have ignored one of the implications of the benefit/cost analysis (cf. Chapter 7) viz, that it is not economically justifiable to attribute more costs to a vehicle class than the benefit it enjoys from the investment. It has been the experience of toll roads in the United States and France that heavy vehicles have been unwilling to use them at the prices charged, consequently prices have been lowered for this type of vehicle by one means or another.

ANNEX 5

The effect of charging for congestion on the pattern of charges

1. The methods of allocating total public cost employed in chapters 8 and 9 had the effect of attributing more cost per vehicle mile to the heavier vehicles than to the light. The purpose of this Annex is to consider whether, if congestion costs were taken into account, as the discussion of short run marginal cost pricing in chapter 5 suggested, the relative cost burden would be likely to change as between heavy and light vehicles. No precise calculations can be presented at this stage: this will not be possible until the work on road pricing[1] is more advanced. The following paragraphs then are a qualitative review of the relative considerations.

2. The principal piece of evidence is the work done on the effect of different classes of vehicle on traffic speeds. Table A5:1 expresses this difference in terms of passenger car unit equivalences (p.c.u.'s) for various classes of vehicle, in different traffic conditions. The Table indicates, for example, that on rural roads heavy vehicles have on average an effect three times greater on overall traffic speeds than cars. In urban areas, the equivalances are rather different, heavy vehicles having relatively less effect than in rural conditions. The p.c.u. values shown in this Table are based on work done in this country by the Road Research Laboratory. Table A5:2 shows the results of work done in the United States. The Table shows that in certain conditions, the p.c.u. equivalences of goods vehicles are very high indeed and that these range widely from one set of conditions to another. In general, the steeper the gradient and the lower the proportion of goods vehicles in total traffic, the greater the effect of an additional vehicle.

3. Tables A5:1 and A5:2 show that heavy vehicles impose more congestion than light: however, there are two factors which tend to counter this effect. First, heavy goods vehicles run a lower proportion of their total mileage in urban areas—i.e. where congestion is most severe. Second, both in urban and rural areas, goods vehicles run a higher proportion of their total mileage outside peak hours, when congestion is less severe.

4. The first point is illustrated in Table A5:3. For all roads, cars, and light goods vehicles show a similar percentage of urban running (53 and 55 per cent respectively), motor cycles and public service vehicles show a higher percentage (62 and 67 per cent respectively) while goods vehicles show a lower percentage (45 per cent).

5. No national statistics exist to illustrate the second point, but there are data from urban surveys and from trunk road censuses which, while not comprehensive, are in agreement. The London Traffic Survey,[2] for example, has produced data on the time distribution of vehicle crossings over the Thames, and of trips into and out of the boundary of the Survey Area. These both show that the time pattern of trips made by heavy goods vehicles is different from light, especially cars. It is less markedly peaked and more evenly spread through the day. A similar pattern is shown up by analysis of census points on main trunk routes.

---

[1] See Annex 7.

[2] London County Council and Ministry of Transport, London Traffic Survey: volume 1, L.C.C., 1964.

6. These two effects only go a small way towards reducing the relativities suggested by the p.c.u. equivalences. Although the pattern of commercial vehicle flow is markedly less peaked, nevertheless a high proportion of their journeys are effected, both on urban and rural roads, at times when they are busy or congested. While it is true that there are important quantities of freight moved overnight, this involves only a small proportion of the total vehicle fleet. Calculations have shown that commercial vehicle flows would have to reach higher than average levels outside normal peak hours and similarly that only a small proportion of their total mileage would have to be run in urban areas to counteract significantly the p.c.u. equivalences.

7. A fourth and last point may be mentioned although it is less clear which way it will affect the balance. It is probable that heavy goods vehicles when parked, at least during loading and off loading, cause more congestion than light. However, they spend a great deal of time parked off the roads—e.g. when being loaded in factories and/or garaged for the night, where they cause no congestion at all.

8. Nothing has been said in this Annex about the effects of introducing congestion pricing on the amounts paid by different classes of heavy goods vehicle. This is discussed in Annex 19.

TABLE A5:1

Passenger Car Equivalents (p.c.u.'s)
(M.O.T. and R.R.L.)

	Passenger car units			
	*Rural roads** *(M.O.T.)*	*Urban Streets*	*Round-abouts*	*Traffic Signals*
Cars and light vans	1·0	1·0	1·0	1·0
Commercial vehicles (Medium)	3·0	1·75	2·8	1·75
Commercial vehicles (Heavy)	3·0	2·5	2·8	1·75
Buses and coaches	3·0	3·0	2·8	2·25
Motor cycles	1·0	0·75	0·75	0·33
Pedal cycles	0·5	0·33	0·5	0·2

* With moderate amounts of gradient and curvature.

TABLE A5:2

Passenger Car Equivalents of Trucks on Ordinary Multilane Highways, on Specific Individual Subsections or Grades

Passenger Car Units (p.c.u.'s.)

Gradient (per cent.)	*Length of Gradient (miles)*	*Levels of Service A to C for:*					*Levels of Service D and E (Capacity) for:*				
		3 per cent Trucks	*5 per cent Trucks*	*10 per cent Trucks*	*15 per cent Trucks*	*20 per cent Trucks*	*3 per cent Trucks*	*5 per cent Trucks*	*10 per cent Trucks*	*15 per cent Trucks*	*20 per cent Trucks*
0–1	All	2	2	2	2	2	2	2	2	2	2
2	¼–½	5	4	4	3	3	5	4	4	3	3
	¾–1	7	5	5	4	4	7	5	5	4	4
	1½–2	7	6	6	6	6	7	6	6	6	6
	3–4	7	7	8	8	8	7	7	8	8	8
3	¼	10	8	5	4	3	10	8	5	4	3
	½	10	8	5	4	4	10	8	5	4	4
	¾	10	8	6	5	5	10	8	5	4	5
	1	10	8	6	5	6	10	8	6	5	6
	1½	10	9	7	7	7	10	9	7	7	7
	2	10	9	8	8	8	10	9	8	8	8
	3	10	10	10	10	10	10	10	10	10	10
	4	10	10	11	11	11	10	10	11	11	11
4	¼	12	9	5	4	3	13	9	5	4	3
	½	12	9	5	5	5	13	9	5	5	5
	¾	12	9	7	7	7	13	9	7	7	7
	1	12	10	8	8	8	13	10	8	8	8
	1½	12	11	10	10	10	13	11	10	10	10
	2	12	11	11	11	11	13	12	11	11	11
	3	12	12	13	13	13	13	13	14	14	14
	4	12	13	15	15	14	13	14	16	16	15
5	¼	13	10	6	4	3	14	10	6	4	3
	½	13	11	7	7	7	14	11	7	7	7
	¾	13	11	9	8	8	14	11	9	8	8
	1	13	12	10	10	10	14	13	10	10	10
	1½	13	13	12	12	12	14	14	13	13	13
	2	13	14	14	14	14	14	15	15	15	15
	3	13	15	16	16	15	14	17	17	17	17
	4	15	17	19	19	17	16	19	22	21	19
6	¼	14	10	6	4	3	15	10	6	4	3
	½	14	11	8	8	8	15	11	8	8	8
	¾	14	12	10	10	10	15	12	10	10	10
	1	14	13	12	12	11	15	14	13	13	11
	1½	14	14	14	14	13	15	16	15	15	14
	2	14	15	16	16	15	15	18	18	18	16
	3	14	16	18	18	17	15	20	20	20	19
	4	19	19	20	20	20	20	23	23	23	23

TABLE A5:3

Vehicle Miles on all roads in Great Britain
1965/66
Urban and Rural Mileage by vehicle type

Vehicle category	*Urban*	*Rural*	*Total*
Cars	52·8	47·2	100·0
Motor cycles	62·1	37·9	100·0
Buses and coaches	63·2	36·8	100·0
Light vans	55·0	45·0	100·0
Heavy goods...	44·9	55·1	100·0
All vehicles	52·7	47·3	100·0

ANNEX 6

Regulations and charges: relative merits

1. In the main text regulations have been referred to as substitutes for pricing. This Annex considers the relative advantages of each.

2. In principle it would be possible to allow everyone to run whatever sort of vehicle they like wherever they liked. Such freedom could be controlled by a complicated system of pricing, which would relate to all the factors controlled by regulations and which would bring home to the user the costs he imposes on other users by operating his particular vehicle. To take only one example, long vehicles would be charged special prices to reflect the extra public and community costs their length causes. Road users would thus be able to choose between the extra costs on the one hand, and the advantages to them on the other, of running the larger, or heavier vehicles. Thus anyone with sufficient resources could use what vehicle he pleased on the public highway so long as he met all the public and community costs he occasioned.

3. There are three main reasons for imposing regulations instead of using the price system. The first is that in some cases, especially those concerned with amenity, an all or nothing choice is in practice, involved. A few parked vehicles may be considered to be as unsightly as a large number. The price would therefore become so high that no one vehicle could afford to pay it, and to charge it would be pointless. It is easier to make a regulation. The second derives from administrative difficulties. Scales would have to be fixed for so many factors and the appropriate place on each scale determined for each vehicle, that the assessment of the relevant charge on a particular commercial vehicle could be out of all proportion to the issues and sums involved. The existing charging mechanisms are in any case insufficiently flexible to reflect the appropriate cost differentials. Yet pricing loses much of its effectiveness if charges cannot be closely related to costs. The system of fees proposed for abnormal indivisible loads is only practicable because of the existing close system of control over movements of this type and it is an isolated example. A third reason is that use of the price mechanism may be regarded as inequitable, since it enables the rich to impose costs on others. Even though these costs are paid for, it may be thought unfair that they should be allowed to do so.

4. Regulations may therefore be used in preference to the price mechanism for various reasons. But, except where administration costs are high, they will not be as economically efficient as, in principle, use of the price mechanism would be. The reason for this is as follows: when governments regulate, for example, the size of vehicles to be used on the road, they try to strike a balance between the gain to operators of being able to use vehicles which offer lower unit costs to them, with the losses that might accrue to other road users through congestion and extra accidents. When the regulation is framed, it is an all or nothing matter, excluding, absolutely, a given type of vehicle. But there may be operators for whom it is particularly advantageous to operate this type of vehicle. If the price of operation where high—reflecting exceptional congestion or road maintenance costs—they would be prepared to pay it, because on balance it would be advantageous; yet they are not, under a regulation, in a position to

do so. There is an evident loss here, which the "coarseness" of the regulation—which may well be justified on balance over all the cases it affects—cannot avoid. Of course, it is often possible to redraw, or use discretion in applying a regulation, so as to exempt particular vehicles from it, when it is possible to identify instances where their use is justifiable.

ANNEX 7

Road Pricing

1. In Chapter 5 it was mentioned that the Road Research Laboratory are investigating the technical feasibility of various systems of charging vehicles for the use they make of roads, which would, in particular, allow congestion costs to be reflected in charges. This work is now well advanced and has reached the stage where contracts have been let for the development of the equipment required for technical feasibility evaluation.

2. The ideal system of road pricing would be both flexible and equitable. Flexibility means the possibility of levying charges according to the road, type of vehicle, and time involved. Equity means that journeys made for similar distances and in similar conditions should bear similar charges.

3. The two charging methods currently under consideration at the Road Research Laboratory are both point-pricing systems, and they both potentially satisfy the requirements of equity and flexibility. In such a system pricing points are located on the roads at fairly frequent intervals and a vehicle is charged each time it passes one. The essential difference between the two methods is in registering the charge. In one, it is registered by a meter carried on the vehicle which is actuated by means of an induction field transmitted from a loop of cable under the road surface at the pricing point. In the other, the loop of cable at the pricing point acts as a receiving aerial to pick up a signal transmitted from the vehicle. Each vehicle has its own code which is passed from the loop to a central computer where the charge is calculated and registered. Differentiation by vehicle type is potentially achieved by having different meters, and given a large enough number of pricing points and the possibility of central switching control, the price of a route could be changed as congestion on the route changes.

4. The potential flexibility of these systems is clearly enormous. If one could be perfected, it should be technically possible to bring about a much closer relation between charges and whatever costs were considered relevant for charging purposes. Technical considerations are not, of course, the only factors determining charging policies. There are others, such as the preparedness of road users to respond to price differences, difficulties of enforcement and other administrative and fiscal problems, which will all have to be taken into account if the technical work shows that improved charging methods can be devised. Until further work has been done on all these, therefore, it is not possible to assess whether a feasible system can in fact be developed.

ANNEX 8

The estimation of congestion costs

1. When an individual vehicle uses the road system it incurs the various user costs listed in Table 2: 1. On many roads, however, it causes additional costs to the traffic already on the roads, in that it increases the time and other costs of these vehicles. This is a clear divergence of private from social marginal cost, where private marginal cost is defined as the cost borne by the user of the vehicle, and social marginal cost is the cost of the vehicle's journey to all the road users. It is very likely, therefore, that there will be some vehicles at the margin deriving less benefit from their journeys than the total costs which they incur and cause (although they will, of course, be gaining more benefit than the costs they are incurring privately). There are economic gains if this traffic were removed, as would occur, if it were charged its marginal social costs. As they are not charged, losses accrue.

2. These losses may be called the costs of congestion. This is giving a specialised meaning to congestion, for it is quite possible that even if each vehicle were paying its marginal social cost, and congestion costs as defined here were therefore zero, there would still exist congestion as popularly understood—queues of traffic at traffic lights or behind heavy lorries on single carriageway roads. This would be "economic congestion", in that the value of the journeys to those causing the congestion would be greater than the costs imposed on the congested vehicles. So it should not be thought that the elimination of congestion costs as defined here on a given road network would mean the creation of free flow conditions.

3. In principle, in order to estimate these costs, the difference should be calculated between the costs and benefits which would prevail if vehicles had to pay their marginal social costs and those which prevail now. This method cannot be used in practice, since it is not possible to estimate what the levels of road use would be, were measures taken to equate private and social costs.

4. Two approaches remain. Before dealing with them in some detail, however, it would be as well to mention the problem of aggregation which arises in applying them. A change in the demand for vehicle miles will mean that congestion costs will fall by any number of different amounts, according to where the change in demand is felt. In the absence of the sort of detailed knowledge which would enable this to be predicted exactly, an assumption must be made about it, and that assumption is normally one of proportionality—that is, that any change in the demand for the service of roads will be distributed among the various roads in proportion to the traffic which they bear.

5. The first approach is to make an assumption about the demand curve for road use. This is the approach followed by the Road Research Laboratory in the Appendix which they prepared for the Smeed report. They assumed that, over the relevant range, the elasticity of demand was unity. (This means that a percentage increase in price would bring about an equal percentage reduction in quantity demanded.) On this basis, using for the cost curve empirically derived relationships between traffic density and speed, and speed and cost, estimates of the level of congestion costs in urban areas only throughout the country of

between £100m. and £200m. were made for 1959/60. One limitation of the method is that there is no good evidence on the elasticity of demand, although some recent work by J. M. Thompson[1] suggests that the elasticity is probably not greatly in excess of the one assumed. Calculations have shown, however, the relative insensitivity of the benefit figure to changes in the elasticity.

6. The second approach is also used by the Road Research Laboratory. This does not pretend to produce a figure which is the predicted result of implementing a new pricing policy but one which might be treated rather as an index of congestion costs. This method subtracts the costs which would be incurred were the present number of vehicle miles to be achieved at a "free flow" speed of 25 m.p.h. from the present level of costs. Present costs are estimated according to the speed cost relationship mentioned above; unfortunately work on an estimate of the frequency with which different speeds actually occur in congested areas is not complete, so rather tentative estimates of average speeds have had to be used. It is probable, given the particular nature of the speed cost relationship, that figures based upon an actual average speed will bias the cost estimates downwards. The R.R.L. have the following estimates of congestion costs, for a mean urban speed of 20 m.p.h. and mean rural speed of 32 m.p.h.: £730m. in 1965 and £790m. in 1966. Since these figures were calculated, further work on the value of time has implied that the value actually used were too high, and has led to an estimate for 1966 of £500m. These figures provide a minimum estimate of the benefits which would result from an investment programme large enough to enable the speed of 25 m.p.h. to be reached in towns, and 40 m.p.h. in the country.[2] These estimates are much greater than the ones referred to in paragraph 5 because account was taken there of the fall in traffic necessary to obtain the higher speeds given that not enough investment could be carried to allow the speeds to be obtained at current levels of flow. Further, the lower congestion figure refers only to uneconomic congestion; it ignores the congestion remaining after a proper pricing policy had been introduced.

7. To sum up: more reliable estimates of congestion costs will have to wait upon estimates of the elasticity of demand, better estimates of the cost curve and perhaps more important than either a detailed investigation into the extent to which averaging damps present estimates of congestion.

---

[1] J. M. Thompson: "An evaluation of two proposals for Traffic Restraint," Journal of the Royal Statistical Society, Series A (General). Vol. 130 Part 3, 1967.

[2] The methods used to make these estimates are described in: D. J. Reynolds and J. G. Wardrop. "Economic losses due to traffic congestion", Traffic Engineering and Control, Vol. 2 No. 7. Nov. 1960.

ANNEX 9

The attribution of road costs to non-road users

1. This Report has attempted to identify all those costs which road users impose on society at large, but no estimates have been presented first, of the costs that other sectors impose on road users and second, of the benefits accruing to non-road users from expenditures on roads, to which they might be expected to contribute.

2. Delays imposed by pedestrians come into the first category. It has been assumed in this Report that these delays cancel the delays imposed on pedestrians by users of vehicles. Even if they did not, it is not clear what conclusions should be drawn. It is difficult to see, for example, how road users could in practice compensate pedestrians or vice versa.

3. The position of statutory undertakings—gas, electricity and water—which enjoy the rights of way roads provide, raises both sorts of difficulty Vehicular road users do not own the roads any more than do these undertakings so they are not in a position to charge rent, but if roads were organised on th commercial analogy then it would be appropriate for the owning/operatin authority to collect revenue from bodies other than vehicular road users, and t reduce the amount payable by the latter. But it would be difficult to estimate a appropriate amount. If, however, the current expenditure approach wer adopted, there would be a weaker case for charging expenditure to statutor undertakings, since the bulk of current expenditure is unrelated to the provisio of new rights of way. However, when roads are dug up to lay and service pipe and transmission lines, this is done at a cost to road users, principally in term of delays. Just as there is an economic case for charging for congestion impose by one road user on another, so there is a case for charging statutory undertakings these delay costs, provided this can be done in such a way as to relat the charges to the costs caused in each individual case, since this would encourag working practices which reduce the amount of congestion caused.

4. A different sort of case is that where roads are provided for purpose other than the provision of better facilities for road users. For example, road might be built at a time of unemployment primarily because of their effect i reducing it. Currently, there are strong pressures for building roads which it recognised are uneconomic from the transport point of view, but which a held to have important effects on stimulating regional development by, f example, encouraging the siting of firms in the areas served by the new ro Here, typically, although road users will benefit, these benefits alone would n be sufficient to justify the road. A large proportion of benefits is presumed to accrue to the inhabitants of the region affected directly, i.e. through the road's effect on industrial location decisions, and not as road users. Again, this case concerns only a small part of total road expenditures, since the bulk is justified in purely traffic terms.

5. Finally, it is sometimes argued that because the roads have a high if not infinite value to the economy as a whole—without them it is impossible to envisage the effective functioning of an advanced industrial economy—that the economy as a whole should contribute to the cost of road provision. But simply

because roads have this central position, it does not follow that they should not be paid for by those that use them. While the provision of better roads obviously increases the efficiency of the economy, there is no evidence that the effect would be greater if they were provided free. And, even if it were, it is not clear that roads as a whole would be a better object for general subsidy than other ways of stimulating economic growth. In particular circumstances, however, improved road communications may be the appropriate means of stimulating economic growth. The Ministry is, therefore, commissioning research work to attempt to measure the effect of road improvements on regional economic activity.

6. In conclusion, while it is clear that a case does exist for requiring non-road users to contribute to the cost of providing roads, the circumstances in which this applies are limited and would not justify a large reduction in the total of public costs attributable to road users.

ANNEX 10

The treatment of Capital in Road Accounts

1. In Chapter 2 it was pointed out that the treatment of capital in any road accounts was not straightforward. This Annex discusses the difficulties involved. The absence of an explicit link between the current costs and revenues arising from the road system comparable to that of the railway system and of other providers of goods and services, and the fact that motor vehicle users took over a system in use for centuries and designed for other users, have complicated what already is a difficult problem. Views on the appropriate ways of allowing for depreciation or appreciation of assets differ, but although there is no method which all would accept, enterprises both public and private have had to attempt to recover their capital outlay somehow by virtue of their corporate status. Consequently, their accounts contain a book value for assets, which may or may not be related very closely to the earning power of the assets. But because of the historical development of the relation between road user tax receipts and road expenditures, no comprehensive accounts have been drawn up and consequently no book value exists. Also, because it has not been necessary in the past to draw up accounts for roads as a whole, the data which would allow their reconstruction, are not available in the appropriate form. It is, for example, difficult to determine to what extent maintenance expenditures have created capital rather than merely maintained it. Not only is it difficult to reconstruct in full detail what the accounts might have looked like if certain conventions had been adopted, but it is also difficult to select conventions for dealing with the expenditure figures available, since there are various ways of doing this. Some of these are outlined in the following paragraphs.

2. In the submission to the Geddes Committee, the Ministry adopted two approaches, recognising that others were possible. The first of these, the "*pay as you go*", or Current Expenditure, method (Method 1 in the submission) suggested that the level of capital expenditure in a given year should be regarded as the capital cost of road provision in that year. Method 2, the "*public enterprise approach*," involved the estimation of a capital value for the road network from figures of estimated capital expenditure in past years. On this an annual charge was levied as a rate of return on the capital "employed", thus paralleling the target rates of the return that nationalised industries in surplus are required to retain.

3. Method 1 has the attraction of representing a lump sum of costs that is actually being incurred almost solely for motorised road traffic. In contrast with Method 2, where any figure calculated must inevitably have little relation to current allocation and use of resources, Method 1 has the merit of reflecting resource use.

4. It is not, however, normal practice to require the current user of a product to pay for all the cost of expanding producing facilities. In most private and public industries a proportion of capital is raised in this way but few firms, if any, of equivalent size of turnover to the Roads Vote are entirely self-financing. They raise part of their capital from the market (if they are a private enterprise) or they borrow (if they are nationalised) from the Treasury and spread the burden of the capital raising over a number of years, i.e. over the period in which the

capital is written off. A variant of Method 1 could be employed to deal with fluctuations in capital expenditure from year to year which would approximate to this pattern. It would involve an estimate of levels of capital expenditure for some years ahead, and the estimation of an annual figure equivalent in present value terms. It could be adapted progressively, to suit future expectations, just as private firms might adapt their borrowing and retention policies in the light of expectations about future levels of demand for its product.

5. If this method were adopted, a capital charge, or interest cost, would be irrelevant from an accounting point of view, for if the expenditure is fully self-financed no interest is paid since there is no borrowing. Strictly, interest should be paid to users since they have provided the capital, but this would be a meaningless book-keeping transaction since any such payment to them would have to be matched by equivalent receipts to cover such payments. A decision to self-finance completely implies a decision that users investing when capital investment is high will in effect subsidise users at a period when investment is low. The reasonableness of the method lies then in a judgement of whether or not it is fair, or for macro-economic reasons efficient, to distribute incomes between users in different time periods in this way. In practice, of course, road users as a group are not in a position to make a choice between retention and low dividends now with high dividends in the future, and the reverse, in the way that shareholders in a private firm may.

6. In the case of roads, the case for Method 1 treatment of capital at the present time is a strong one. Capital expenditure and traffic are both rising and are likely to continue rising for some years. Although, naturally, little can be said about expenditure in the 1970's, it would be reasonable to anticipate some further increase. Traffic too will continue to increase though more slowly than at present. If these predictions are fulfilled, and if, therefore, the burden of capital cost per vehicle does not fluctuate widely, then the main reason for treating capital differently from other costs no longer applies.

7. The economic advantages of this alternative are considerable. Levying a charge on past capital expenditure has no economic purpose. It contravenes the economic principle of letting "bygones be bygones".[1] As is argued in Annex 17, this method therefore gives the best available approximation to long run marginal cost pricing, which (as Chapter 5, makes clear) has merit from the point of view of the efficient allocation of resources.

8. Method 2 is an attempt to devise for the road system a set of accounts comparable to a public or private firm. The method involves two stages: first, estimation of the capital value of the road system, and second, choice of a rate of return to be earned on these assets. Both of these stages present considerable difficulties.

9. The estimation of capital value can be approached in three ways:

(*a*) by valuing the assets in terms of their earning power;

(*b*) by assessing the historical cost of the capital;

(*c*) by assessing the replacement cost of the system.

---

[1] cf. Chapter 5.

The first of these approaches can be applied in two ways, first by estimating the value of the system in terms of its most profitable alternative use; this value sets a lower bound to what roads should be able to earn in their existing use, since otherwise it would pay to divert to the best alternative use: second, by estimating the maximum the system could earn in its existing use, which ought, of course, to be greater than the former figure. The first variant will be included in the discussions of land values below, since, at the present time, the roads as such have negligible alternative use value and only have earning power because of the space they occupy. The second variant is not relevant in the present context. A firm considering the purchase of another will naturally consider what the assets can produce in terms of profit, rather than what they actually cost in the past or will cost to replace in the future. Similarly if a firm possess assets whose earning power has increased because of changes in the pattern of demand, it is appropriate to write up the value, so that the firm's current performance can be related to a realistic standard. But none of these considerations apply in the case of roads, given that they are not to be run in such a way as to bring maximum profit to the Treasury.

10. The second approach, using historic costs, was the one chosen by the Ministry, principally because this offered the best approximation to the practice in nationalised industries. There are three types of difficulty with this approach; first, motorised road users took over an existing system, which clearly saved a considerable amount of expenditure. There is, therefore, a case for attributing some value to the system as they took it over, but it is not obvious how this problem of initial valuation should be tackled. The second difficulty is a statistical one. Although figures are available for new works and major improvements a great deal of maintenance and minor improvement expenditures are of a capital nature and it is only possible to infer from analyses of the breakdown of current expenditures what the capital element in expenditure may have been earlier. Third, there are various possible ways of writing-off the capital. In the Ministry submission, capital expenditure was not written off but merely accumulated, whereas the Transport Holding Company[1] suggested an alternative procedure—writing off the capital over a period of 40 years. In most contexts, there would be no justification for failure to depreciate capital. But in the case of roads, this practice can be defended: first, because many of the assets are of a non-renewable nature, and second because those assets, e.g.road surfaces which do physically deteriorate, are maintained in such a way that their physical condition has been improved rather than allowed to decline. The T.H.C. procedure, however, is more nearly that which might be adopted by a firm which, although recognising that its assets are not physically declining in value, nevertheless writes them off as a hedge against the possibility that they will lose their economic value through the emergence of new forms of transport. The period of 40 years reflects the confidence it seems reasonable to place in the life of roads as economic assets; if for some reason their technical obsolescence appeared imminent, then there would be a case for shortening the writing off period. At the present time, 40 years might appear too short rather than too long.

11. The third approach using replacement cost values suffers from the same difficulties as the second. Some life for the assets must be assumed. The authors

---

[1] See Annex 3.

adopting this approach have applied different ones. The figure for the capital value of the road system published in the National Income and Expenditure Blue Book is based on an assumed life of 75 years. Stewart[1] on the other hand adopted 50 years for non-renewable assets and 30 for renewable. These authors do not explicitly tackle the problem of the valuation of the road system at the time it was taken over by motorists, but it is implicit in the lives assumed. The Blue Book figure implies that only expenditure since 1892 has a value now: Stewart's, that no pre-World War 1 expenditure is relevant.

12. Different views may also be taken as to what expenditure comprises. The Blue Book figure omits an allowance for land and other costs associated with the road building other than construction, and it does not include minor improvements. Stewart includes the latter but not the former, while Prest[2] amends the Blue Book figure to allow for land and legal items, but does not include minor improvements. The statistical difficulties in applying any of these definitions are, of course, the same as for any historic cost calculations.

13. The discussion so far has been in terms of total capital costs. One of its components, land, is frequently treated separately, because of its peculiar economic characteristics. Although it may change in value through time, it does not, in the usual sense of the words, wear out. It retains its basic attribute of being an area where economic activity can take place, and, more than most capital assets, it may rise in value through time, as demands for a particular location change. Thus, not only may the divergence between historic and replacement values be much greater for land than for the other components of roads capital, but land embodied in roads may retain or increase its economic value, while the other aspects of roads, the carriageways and earthworks etc. may have none at all.

14. There are two ways of determining how land should be charged to road users. First, it could be argued that road users should pay the alternative use value of the land roads occupy. If they are not able to pay this much, then the land should be given over to other uses; if they are, then it should be retained in its current use. This is the test that any enterprise, public or private should apply to the land it uses.

15. In rural areas, the alternative use value would probably be very low, since the cost of breaking up a road to convert it to other uses would almost certainly be prohibitive and there are, currently, few if any uses which would require the roads in their present state. But in urban areas, where land values are much higher, the actual condition of a site is much less of a barrier to its development and consequently the possibility of a change in use is a real one.

16. But a major difficulty arises in determining what this alternative use value would be. It would be possible to value all urban road land at the value of the land through which it passes, on the ground that this is the price that would have to be paid now to buy land in these areas. The normal counter to this approach is to argue these land values depend in turn on the existence of

---

[1] J. M. W. Stewart: "A pricing system for roads", University of Glasgow Social and Economic Studies, Occasional Paper No. 4, Oliver and Boyd, 1965.

[2] A. R. Prest: "Some aspects of Road Finance in the U.K.", Manchester School of Economic and Social Studies, Vol. 31, No. 3, Sept. 1963.

roads and in their being used by motorised traffic. But the mere fact of interdependence is not sufficient to eliminate the case for charging, since all demands for land in an urban area interact and so are mutually determined, and there are land uses, such as basic services, the withdrawal of which would have almost as devastating effect on land prices as the withdrawal of motorised traffic. These users are, however, minor users of land. The price with which they are faced has little effect on their demand for land and on the pattern of land use as a whole. This may not be true if road users were charged on the basis suggested, especially if the charges on particular roads were related closely to land values obtaining there. There might follow changes in the pattern of land use including the amount devoted to roads, that would appreciably change the values used for the initial valuation. Consequently, the value arrived at by taking the values in force now on sites bordering roads may seriously misrepresent the value that would obtain if that price were actually charged.

17. An alternative, yet related, approach is the following. Following the analogy of the nationalised industry introduced in Chapter 5, it could be argued that the road industry should show a return on its land comparable to that of other landowners. As roads are fairly well geographically spread and are not confined to areas of high or low land values, then it could be argued that they should produce a rental value equal to the average of that obtained from other land. Unlike the previous approach, this assumes, first, that the space currently devoted to roads ought to be so devoted, second, that the commitment would only have taken place had the land been able to make a return under road use comparable to that under other uses, and third, that as land values have risen, it has been possible to raise the value of land embodied in roads *pari passu* with other land values.

18. This approach, because it does not take into account the costs of converting land to alternative uses, nor make any allowance for changes in land values resulting from the rent charged, will tend to produce land values, and consequently rentals, rather higher than the alternative use approach.

Choice of Method

19. What criteria might be suggested to enable a choice between the various methods, which not only differ on the level of theory, but also, as Annex 13 makes clear, produce very different capital values? It is necessary first to be clear about the nature of the choice; it is largely a matter of equity not of economics. The costs have been incurred and they are largely sunk in assets with no alternative use value. Their recovery from current users rests on a judgement about the fairness of letting road users, as opposed to the users of many other facilities, off the burden of covering the capital costs that have been expended on developing the road system. A standard of what is or is not fair may be looked for in other sectors. But this is of little help. The railways, the most obvious source of comparison, have a very confused and involved history of capital valuation, in part determined by considerations that do not apply in the road sector—above all by their recent failure to earn a return on the assets values that have appeared in their accounts. The other nationalised industries do not present a uniform picture. Two of them, B.O.A.C. and the N.C.B. have required major capital reconstruction for reasons peculiar to

these particular industries. Gas and electricity have had a more settled history, but the economic circumstances of these industries are different from those of roads: the life of capital is much shorter, not only because it physically deteriorates, but also because the rate of technical change is such as to make plant obsolete fairly rapidly.

Conclusion

20. It is reasonable enough to attach some value to the road system and charge current users on the basis of it, since this is what happens in other parts of the economy. Comparison with other sectors does not, however, suggest a unique figure for valuing roads, and the discussions has shown that the choice between the various possibilities is a difficult one. But there are two reasons for not making too much of these difficulties. Firstly, because in the case of other industries decisions have in fact been reached on appropriate capital values; the problem with roads is not unique. Secondly, how important they are depends very much on the approach adopted to charging policies. The estimation of a capital value for the road system is only required if certain charging principles are adopted, and as this Annex has argued, other ways of treating capital are, in any case, preferable.

ANNEX 11

Rates as a road cost

Rates were not included in Chapter 2 as a cost to be charged to road users although the argument has been advanced by Prest[1] that they should be. Other government properties are currently rated and rates are in fact charged, but it is not easy to find an acceptable basis for similarly taxing roads. Any estimate of what the appropriate amount would be is extremely difficult to make. Rateable values vary according to the use to which property is put; agriculture for example, is de-rated, while industry and private house owners are not. Roads are used by all three categories. These are difficulties of practice. But there is a strong argument of principle against charging road users rates, namely that they do not benefit as road users from the services provided by local authorities, except from those such as cleansing, policing and lighting, which have already been included in the public costs of road provision. Consequently there would be a risk of double counting. Ultimately, however, this question is not a transport matter but one of general fiscal policy. No estimates therefore will be offered in this Report of what an appropriate level of rates should be.

---

[1] A. R. Prest, op. cit.

ANNEX 12

The evaluation of accidents costs and loss of amenity due to vehicle noise and fumes

1. The fact that economic activities give rise to costs external to them is now a familiar one. The owner of a factory takes account of the labour and the raw materials he must pay for as well as rent on his premises and interest on his capital. These together comprise to him his costs of production. But there may be other costs—called external costs, as they do not feature in his accounts—which are just as much part of production costs as any of the items he actually pays for—the pollution he may cause in neighbouring rivers, the dirt he puts into the atmosphere and so on. The only reason why these costs are external is that no means has been employed of bringing them home to the originator of them, as would, for example a tax on the amount of dirt discharged into the air. It is nothing to do with the nature of the costs themselves.

2. These external costs fall into two categories: economic costs, and subjective costs. River pollution may raise the cost of supplying water for domestic use. In principle this could be estimated in terms of the cost of the extra raw materials and labour required for additional purifying processes, although in practice it may be difficult to do so. Both the materials and the labour are already given a value—their price—which can be readily used to evaluate the cost of the operation. These therefore are economic costs. But the river pollution may reduce the attractiveness of the surrounding region, a cost felt directly by those wishing to use it as an amenity area. This cost would, therefore, be termed subjective.

3. Both categories of external cost give rise to considerable problems of evaluation in practice. These are naturally greatest with the subjective costs. Because no price exists, the evaluation has to be effected by indirect means. For example, while there is no market for peace and quiet as such, nevertheless examples may be found where people have incurred costs to avoid noise, by paying more for a secluded site, or by spending money on soundproofing. Expenditure of this sort is some indication of the strength of people's preferences for freedom from noise, but although this method may appear to be a fruitful one, in practice it is usually difficult to apply: no example may exist which makes indirect evaluation possible or, where examples do exist, it may be impossible to sort out the particular value concerned from a host of other factors.

4. Economic costs are frequently no less difficult to evaluate because of the empirical and theoretical problems that they raise. On the former point few data are available on many of the relevant cost items and relevant data are often difficult to collect: on the latter point, it is frequently difficult to distinguish the effects of road traffic from the other causes contributing to costs concerned. This is true in the case of noise and air pollution.

5. The following sections therefore are intended only to indicate the possible extent of these costs and to the methods available for their evaluation. A great deal of further research will be required before any firm figures can be produced.

Accidents

6. When a person is injured or killed in a road accident various classes of cost are occasioned, some of which are borne by the victim, other by the exchequer and the community as a whole: these costs may be subdivided thus:

(1) Medical costs.
(2) Lost output.
(3) Administration of insurance, police etc.
(4) Damage to vehicles and other property.

These comprise the total economic costs to which accidents give rise. The cost falling on the community as a whole is mainly the output lost as a result of fatal and serious accidents, as clearly the community as a whole is impoverished by the loss of the savings both corporate and private that the injured party would have added to society's stock of assets. For 1965, this has been estimated at £30m.

7. The difficulties in evaluating net lost output derive from the conceptual problems inherent in its definition. Lost output here is calculated net of future consumption, on the grounds that while society loses a victim's output it gains by not having to supply his consumption. Thus in any given year the net loss is the difference between the two, and the total loss is this difference discounted over the appropriate future period. Consumption is taken to be only personal consumption. It would be valid to deduct public current expenditure if it were reasonable to suppose that the magnitude of these expenditures were sensitive to small changes in the size of the population at the margin. As the change in population due to accidents is less than ·015 per cent per annum it is unlikely that any variations in these public expenditures would be discernible. Estimates of consumption therefore take no account of the individuals share of collective public expenditure. Lost output itself is not easy to identify. Reynolds[1] took as his measure of lost output the individuals share of GNP weighted by the wage rate. This recognised the problem that except under certain assumptions output cannot be identified with the wage rate. Yet it does not, for several reasons supply an entirely acceptable solution, and is possibly an overestimate. Using American experience and such British data as exist, other methods have been explored that allow better estimates to be derived. However the problem does not end here. Certain classes of persons, notably housewives, do create output but receive no paid wage, and clearly society is impoverished by their loss. However, the difficulties of estimating their loss of output in money terms are considerable. It has been assumed both in British literature and in studies conducted abroad, that the value of a housewife's output is equal to the average paid wage of an employed female. This would seem to be oversimplified, in that it is clear that the value of the work of a woman with for example five young children is not equal to the output of a housewife with none, nor is there any plausible reason why either should be equal to the average female wage. Estimates have, therefore, been prepared relating to the value of the services produced to the actual work-load.

---

[1] D. J. Reynolds: "The Cost of Accidents in Great Britain", Journal of the Royal Statistical Society, Series A, Vol. 119, Part IV, 1956.

8. The public economic costs are mainly the medical expenses of hospitals and general practitioner treatment, net of the payments made by victims and their insurance companies under sections 212–24 of the Road Traffic Act 1960. Other public costs are legal and medical time.

9. As was mentioned previously, there are also subjective community costs, the cost of suffering and grief. An approach to the evaluation of these costs can be made by observing the implied financial values that society attaches to life in various fields where safety expenditures are made, and the implied cost per life saved can then be determined. The values that this method throws up vary widely, life being worth many thousands of pounds in some circumstances and very little in others, indicating if nothing else that the problem has received no detailed attention. Another method of valuation is to consider the values placed on life and injury by courts, when damages are awarded for personal injuries, although such values are affected by extraneous considerations such as contributory negligence. However, on certain assumptions, estimates have been made which indicate that the subjective cost of accidents in 1965 are of the order of £125m. Only a fraction of this total is a community cost. Part is already borne by vehicular road users, because they themselves suffer the majority of road accidents, and they meet a further part through the compensation payments they, or their insurance companies, make to pedestrians or to the dependents of road users. The remainder, the community cost element, has been estimated at between £30m. and £40m.

Noise

10. Although a great deal of work has been done on the effects of noise, particularly aircraft noise, and measures have been devised of their relative tolerabilities, little research has been completed on the evaluation of these costs either of noise in general or traffic noise in particular. One way of evaluating the subjective cost is to consider the cost of protecting people from noise. The Wilson Committee[1] report on noise showed that traffic noise was in most parts of London the predominant noise-annoyance and that about one fifth of the whole area might be considered noisy. If this were true of all urban areas, about 2½m. dwellings in Great Britain might be affected. The cost of soundproofing these might be of the order of £450m. (in annual terms, £36m. at 8 per cent). But such a figure could be said to over-estimate these costs because, as a matter of fact owners have in most cases not chosen to soundproof their dwellings. This would imply that they valued their freedom from noise at less than the soundproofing cost.

11. But the matter is more complicated than that. Soundproofing is not one hundred per cent effective, and people are, on the whole, badly informed as what soundproofing can achieve. Further, they might not wish to spend money on it, fearing they will not get it back on resale—or because they do not own the property themselves. All these points suggest that the degree of overestimation may not be large. Further, data in the Wilson Report showed that about 20 per cent of the number disturbed by road traffic noise were disturbed at work,

---

[1] Final Report of the Committee on the Problem of Noise (Wilson Committee) (Cmnd. 2056).

and over half disturbed when out of doors. The former group could be protected by soundproofing in most cases, but in the latter case this is not feasible; and other methods, e.g. noise control through standards, has to be relied upon. Here the Wilson Report suggested that the costs of imposing standards on road vehicles higher than those they recommended could only be done at considerable costs, which in their judgement could not be justified. But even at the standards recommended, and now largely accepted, subjective costs continue to be imposed.

12. An alternative approach to the evaluation of noise is to consider the effect of noise on land or property values. In some instances, aircraft noise has been recognised as a reason for granting rate reductions of the order of 7 per cent of the rateable value of a £5,000 house.[1] If this is assumed to be expressed in a reduction in the capital value, this would imply in annual terms about £30 per house. No systematic data are available on the effects on property values although there is some evidence that the building of the overhead section of the M.4 has depressed house values by large amounts in the immediate vicinity. Not all of this, however, can be attributed to noise alone.

13. Thus, little evidence exists as to the magnitude of the subjective costs of noise. The same is true of the economic costs, but various studies have been undertaken[2], which illustrate the various types of economic cost noise imposes and provide pointers for future quantitative research.

14. Noise may be a contributory factor in accidents both in the home and on the roads, as noise causes a loss of concentration and therefore increases risk. It has been shown, for example, that a motor horn at 2 yards distance giving a noise level of 95–100 phons, causes a decreased visual reaction of 25 per cent. The possible consequences of this are obvious, nor is such a noise level uncommon in busy urban areas.

15. Loss of concentration, as well as constituting an accident hazard, can impair productive efficiency thus giving rise to economic costs. Experiments have been conducted in post offices, for example, which showed that when the noise level was increased from 75 to 95 decibels, productivity fell by 25 per cent, and mistakes in mail sorting increased fourfold.

16. Continuous noise can also be a danger to health, causing deafness, as well as disorders of the nervous system. No estimate of the responsibility of noise for the latter is possible, but the risk of damaged hearing is now well recognised. In the U.S.A., it has been estimated that about one million workers have serious hearing loss due to high levels of noise at their places of work. The potential cost to American industry through compensation for industrial deafness is estimated at $500m., on the assumption that only 10 per cent of persons who work in areas of intense noise file claims.

17. In summary, therefore, the costs of noise, both economic and subjective, appear to be large, although at the present time they cannot be estimated: what proportion of these costs may be attributed to road vehicles, even if it were possible to measure them in total is, of course, equally uncertain.

---

[1] Quoted in R. A. Waller and R. J. Thomas "The Valuation of Amenity" (W. S. Atkins and Partners Technical Communication), The Company 1965.

[2] Reported in "Noise Pollution", U.N.E.S.C.O. Courier, Vol. 20, July 1967.

Smoke and Fumes

18. As with noise, there are considerable difficulties in making an estimate for the subjective costs of smoke and fumes. However, data exist which allow a plausible estimate to be drawn of the economic costs. Of the estimates currently available, the most authoritative are to be found in the Final Report of the Committee on Air Pollution.[1] From the various estimates given in an Appendix to the Report, it was clear that there was a difference of opinion as to what the magnitude of the costs could be, and indeed the Committee emphasised strongly the hazardous nature of such calculations. However, the Committee estimated that, taking into account damage to buildings and structures, corrosion of metals, laundry costs and loss of efficiency, the cost could be placed at £250m. in 1953. The major cost components were as follows:—

(1) *Laundry and Household Goods*

This category comprised laundry and washing whether or not done at home. The estimated cost was £35m.

(2) *Damage to Buildings*

The two main items which can be estimated under this heading are the costs of cleaning and painting and decorating. The Committee's estimates were £30m. for painting and decorating and £20m. per annum for cleaning and depreciation of non-domestic buildings.

(3) *Corrosion of Metals*

This item which covered not only the cost of corrosion but also the cost of protective coatings was put at £25m.

(4) *Damage to Goods*

The Committee estimated the cost of damage to textiles at £50m. and the cost of damage to goods in shops at £2·5m.

(5) *Lighting and Medical Services*

The Committee were unable to offer an estimate for these items, but there is evidence which suggests that the medical costs might be considerable. Air pollution is, for example, a contributory factor in deaths from respiratory diseases, one of which, chronic bronchitis, is responsible for about one-tenth of all deaths in Britain.[2]

(6) *Loss of Efficiency*

The Committee took into account damage to crops and soil, disruption of transport due to smog, and the loss of labour efficiency. Its estimate here was £10m.

19. Since this time, however, the Chairman, Sir Hugh Beaver, has subsequently stated[3] that these estimates were too low, and that a figure of £400m. would be more appropriate. Taking into account the fall in the value of money

---

[1] Cmnd. 9322.

[2] H. Wolozin, Ed. "Economics of Air Pollution", W. W. Norton, 1966.

[3] In a foreword to A. Gilpin, "Control of Air Pollution". Butterworth 1963.

on the one hand and the fall in pollution on the other, it has been suggested that a figure of £350m. is appropriate for the present time.[1]

20. This represents the total cost of pollution; it is necessary for current purposes to determine what portion of this is attributable to vehicles. No data are available for Great Britain, but evidence from France suggests that exhaust fumes are responsible for 25 per cent of air pollution. This is a physical measure, which may not represent pro rata responsibility for the costs.

---

[1] Quoted in A. R. Smith, Air Pollution (Society of Chemical Industry Monograph 22), The Society, 1966.

ANNEX 13

The estimation of capital values for roads

1. As Annex 10 has shown, there are many ways of estimating the value of the road system. The purpose of this Annex is to indicate the range of magnitudes that result from different approaches to the problem, and to indicate why the value taken for the specimen capital charges as presented in Chapter 3 of the main Report was chosen.

2. Estimates of the capital value of roads are already available from various sources. The National Income Expenditure Blue Book indicates a value of £2,470m. for 1965. This is a replacement cost figure—i.e. historical costs have been updated hy means of a price index. Capital is retired from the stock after 70 years. Currently retirements are running at very much lower levels than additions since investment is much greater at present than 70 years ago, so that the stock is rapidly growing.

3. The definition of capital used in this calculation is, however, a restricted one. Prest has suggested[1] that the figure should be marked up by 14 per cent to allow for certain related expenditures, e.g. land and legal fees, which are not included hut which would form part of capital cost for a commercial concern. Applying this addition brings the total up to £2,816m.

4. An alternative, historical cost, estimate was put forward hy the Ministry of Transport in the submission to the Geddes Committee (see Annex 2). This method too produces a rapidly rising figure since the real and money values of the current capital expenditure are high relative to expenditure over the period beginning in 1909 which the Ministry took. In 1965 it would amount to about £2,050m. It is perhaps surprising that this amount is so little less than the replacement cost calculation referred to above, given too that the latter includes capital expenditure over a longer time period. The smallness of the difference is largely due to the wider definition of capital expenditure employed—the Ministry figures includes an allowance for minor improvements expenditures which compensates for the use of historic prices. Further, the two sums are hoth greatly affected by recent expenditures, where the difference between the two methods of capital estimation are slight.

5. A precise estimate cannot be made from the difference it would make to the National Income and Expenditure figure to include an allowance for minor improvement. It might be of the order of £600m. hringing the total to about £3,400m.

6. The figure for capital charges in Table 4:2 was calculated in four stages. First, a capital value for roads was assumed of £3,000m. This was chosen to fall in between the highest and the lowest figures quoted above.

---

[1] Op. cit.

7. The second stage was to assume a rate of return on these assets. By analogy with the C.E.G.B., the rate chosen is 6 per cent.[1] The third stage is to make an assumption about the degree of self-finance that might be required from the roads industry. It has been assumed that 50 per cent of capital requirements would have to be raised directly from road users, as roads are a rapidly expanding sector and, if they were organised commercially, would be a prosperous one. This proportion is rather higher than that currently raised from electricity users. No depreciation has been allowed for, on the ground that road capital is physically maintained by current expenditures.

8. The fourth stage is to make a special allowance for the land component of roads capital. Assuming that the roads industry would be expected to earn from its land a sum similar to that being earned on comparable land in other uses (following the second approach outlined in Annex 10) a figure may be derived by considering the proportion of land situated in areas of different levels of land values. This approach has been followed by G. J. Roth[2] who estimated that a figure of a little over £72m. per annum would be appropriate. The values he assumed for residential sites, however, seem low; consequently his estimates have been increased to make a total of £100m.

---

[1] Cf. Central Electricity Generating Board, Report and Accounts for 1966/67, H.M.S.O., 1967.

[2] G. J. Roth, "A Self-Financing Road System", (Research Monograph No. 3) Institute of Economic Affairs, 1966.

ANNEX 14

(*a*) Vehicle mile and vehicle fleet forecasts

1. The vehicle numbers and vehicle mileage forecasts for cars, buses and motorcycles used in this Report have been taken from "Forecasts of Vehicle ownership in Great Britain" by J. C. Tanner of the Road Research Laboratory.[1] Light vans and heavy goods vehicles have been forecast separately, as will be indicated below.

2. Tanner's forecasts for car population are the result of fitting a logistic curve to data of car ownership per head. The forecasts estimate that the number of cars will double between 1965 and 1975. Tanner suggests that the annual mileage per car will not change, so the total car mileage is expected to increase at the same rate as the number of vehicles. Public service vehicles are assumed to remain constant in numbers and their annual mileage is assumed to be unchanged; this is an extrapolation of the trend over the past few years and there appears no reason why this trend should not be projected. The motorcycle population is expected to decrease as is their annual mileage, since with increasing affluence cars are bought instead. This decrease is expected to continue until a lower limit in motorcycle population is reached.

3. Tanner also gave forecasts of commercial vehicles miles (implicit in his "Other vehicle" estimates). For the purposes of this Report these forecasts have been modified. Their main weakness for current purposes is that they do not provide estimates of the composition of the commercial vehicle fleet, and do not take explicit account of the implications of recent changes in the size structure of the existing fleet. The methods used to obtain an estimate of the future vehicle fleet are described in the next section.

---

[1] J. C. Tanner, "Forecasts of Vehicle Ownership in Great Britain". Roads and Road Construction, Nov. and Dec., 1965.

(*b*) **The future commercial vehicle fleet:**

1. The most marked feature of the commercial vehicle fleet over the past decade has been the rapid swing towards large vehicles.[1] This trend results from changes in the Construction and Use regulations (which have allowed higher operating speeds and larger capacity vehicles), the availability of motorways, the rising cost of labour, and changes in the performance available from the largest size ranges. Larger vehicles offer lower costs per ton mile; the factors mentioned have reinforced the inherent cost advantage of the large vehicle.

2. The trends among the heavy vehicles are not reflected in the lighter. The latter are frequently not load carriers and even where they are, they carry small amounts over short distances and can consequently never achieve the loads and utilisation rates which makes the larger vehicle economic. Hence for the purposes of prediction it is appropriate to divide the fleet into two sections and consider them separately. Heavy vehicles over 3 tons unladen weight are considered first.

3. The required capacity of the fleet is determined by the demands upon it. Projections have been prepared of the future volume of traffic on various assumptions about the relation between demand and G.N.P., the rate of growth and the division of traffic between road and rail. The trends in the vehicle fleet can now be set against the demand for capacity. The inherent cost advantage of heavier vehicles, together with the factors mentioned above, is leading to investment in heavier vehicles to replace the old smaller vehicles. This simple replacement will, by itself, increase the capacity of the fleet, since the larger vehicles not only have a larger capacity, but they tend to perform more miles per annum. On the assumption that utilisation and load factors for a given vehicle weight group change very little over the next decade or so (an assumption which the surveys of Roads Goods Transport carried out by the Ministry over the last 15 years indicate is reasonable) the swing in the composition of the fleet represents an enormous increase in its capacity for work. If this continues at current rates, capacity will grow faster than demand. Thus assuming that the replacement of scrapped vehicles by heavier vehicles continues, only a small increase in the numbers of these vehicles is required to meet future increases in demand because the new vehicles have a larger capacity for work than those they are replacing.

4. It is the assumptions that are made about the utilisation and capacity of operators' replacement vehicles and the continuation of the trends that are the more important, rather than the assumptions about the rate of growth in G.N.P. or the relationship between demand for transport and G.N.P., in determining future vehicle fleet size and composition. How reasonable is it to consider that the trends will continue? Understanding of the reasons for vehicle choice and the growth of demand in particular industries are not complete enough to enable any firm predictions of how long the present trends will continue, but all the factors that have been mentioned as explaining the current switch will continue to apply over the coming years, though possibly to a less marked extent. Consequently it is reasonable to project a continuation of

---

[1] See Table A14:1.

current trends, but at a more moderate rate than in the recent past. This reflects assumptions about the demand for transport which include the new quality and quantity licensing proposals and an expectation of their effect on the division of traffic between road and rail.

5. Prediction at the lighter end must rely on a completely different approach. The demand constraint introduced above has little force for this class of vehicle as their contribution to total ton mileage is negligible. A cross-section analysis of the smaller vehicles by area of registration has been carried out to see if differences between parts of the country can be explained statistically in terms of income differences and other factors. This work is not yet complete, but on the basis of provisional results it is now expected that light vans will grow in numbers at a rate less than, or equal to, population. This work, then, suggests only very moderate growth and, allowing for declines in certain weights between light vans and vehicles over 3 tons unladen weight, the overall forecast is of a commercial fleet which grows very slowly in actual numbers of vehicles, although the fleet capacity will grow much more quickly.

TABLE A 14:1

Numbers of General Goods Vehicles Currently Licensed 1960-1966

Unladen weight		1960	1961	1962	1963	1964	1965	1966
Over	Not over							
1½ tons	2 tons	83	84	81	81	80	76*	71
2 tons	3 tons	265	246	229	223	211	193	175
3 tons	5 tons	186	212	225	244	260	269	270
5 tons	8 tons	41	47	52	61	70	76	87
8 tons	...	11	13	15	17	20	24	28
Total ...	...	586	602	582	646	641	638*	631

* Revised estimates.

ANNEX 15

Public road costs and the use of the roads by particular vehicle classes

1. This Annex examines the relationships between the public costs of the roads and their use by particular vehicle classes.

Capital: scheme design

2. Since the publication by British Railways Board of their paper "The Relative True Costs of Road and Rail Freight Transport over Trunk Routes"[1] the aspect of this that has received most attention has been the proportion of inter-urban motorway cost due to their design for use by heavy vehicles. The paper estimated that the proportion of capital costs incurred solely to provide for heavy vehicles was 70 per cent for dual carriageways (£350,000 out of £450,000 per mile) and 71 per cent for 3-lane motorways (£500,000 out of £700,000).

3. These figures received little support from other authorities. The Ministry in its evidence to the Geddes Committee presented an alternative figure for rural motorways of 17½ per cent, and this proportion was broadly confirmed by other bodies including the Road Research Laboratory.

4. The Ministry has subsequently reviewed the figure prepared for the Geddes Committee in consultation with the Road Research Laboratory and it sees no reason for changing its views. It recognises that difficulties are attached to the precise estimation of a figure of this kind, but it is considered that any improvement that might be made would be a refinement of the earlier figure and not a major change.

5. The figure prepared by the Ministry has an important limitation: it was prepared only for rural motorways. The Ministry considers, and this view is again supported by outside experts, that the savings in rural dual carriageway schemes would be very similar to those on motorways. The analysis of road costs carried out by Dawson[2], however, indicates that the cost structure of urban and inter-urban schemes are rather different. Consequently, if it is assumed that the proportionate savings in each cost category are the same for urban and inter-urban schemes, a rather lower figure than 17½ per cent emerges, since the items where savings are largest, principally carriageway and earthworks, are more important for the rural schemes. Further, land costs, which are omitted from the calculation, will be little affected by the need to provide for heavier vehicles, and are an important item in urban costs. Consequently, for the purposes of cost allocation in Chapter 8, a figure of 15 per cent has been taken.

6. For small inter-urban schemes the proportion should probably be somewhat higher. A number of these schemes have been analysed and it has been found that carriageway costs make up on average a rather larger share of total

---

[1] See Annex 4.

[2] Road Research Laboratory, Technical Paper 50: "An analysis of the cost of road improvement schemes", by R. F. F. Dawson, H.M.S.O., 1961.

costs than for larger schemes. Allowing for other factors, such as earthworks, a rather higher figure of about 20 per cent has been estimated. Unfortunately, these schemes do not have the homogeneity of motorways or dual carriageways, where design standards differ little from scheme to scheme. Consequently the figure of 20 per cent is not as firm an estimate as that for motorways, but it is unlikely to be far wrong.

7. One assumption in the 17½ per cent calculation that has subsequently received some critical attention is that lane widths would be unchanged. The Highway Cost Allocation Study,[1] for example, assumed it would be possible to reduce lane widths from 12 feet to 9 feet if heavy vehicles were not expected to use the roads concerned. At high speed, light cars can be considerably affected by cross winds (more so than heavy vehicles) and consequently fairly generous lateral clearances must be allowed. Such allowances also have the effect of increasing the capacity of the road concerned as there is a fairly close relationship between lane width and capacity. Drivers are affected by the fact that they are moving fast relative to others in close proximity and tend to drive more slowly as a result. It is possible that a reduction to 11 feet could be accepted but the importance of the safety factor means that reduction of width would be much less than capacity considerations alone would suggest.

8. The above paragraphs have supported the Ministry's earlier contention that the proportion of total road building costs that would be saved were heavy vehicles not provided for was fairly low. All the figures produced, however, have been prepared on the assumption that the pattern of investment would not be altered if roads were not built for heavy vehicles. In urban areas, where it is much more difficult to fit roads into the physical environment, it is probable that if heavy vehicles were not catered for certain geometric standards for road design, e.g. clearances, could be eased at some saving. In rural areas this effect is probably less important, but even here it is possible that different lines would be chosen, paying less regard to gradients, than those now selected. These points cannot be quantified.

Capital costs: the amount of capacity provided

9. This is a much more difficult problem than that reviewed in the previous section. The difficulties are conceptual as well as practical. To tackle it the factors which influence the decision to commit resources to road investment will be analysed.

10. If investment in roads is justified by the benefits it is expected to produce, even where these are not formally calculated, and not by the revenue a scheme produces, then it would seem reasonable to argue that the responsibility for investment of each vehicle type depends on the share of benefits that it receives from the scheme concerned. This argument has already been shown, in Chapter 7, to be difficult to apply. This section illustrates the conceptual difficulties involved by imagining how a private enterprise and profit-making road building authority, which could charge directly for the roads it provided, would act.

---

[1] See Annex 1.

11. Such an authority might have two effective investment alternatives when considering whether or not to build a new road: to build a road for light and heavy vehicles, or to build one just for light vehicles. A decision between the two would be reached by computing the revenue from the light vehicles only road, and then estimating whether the extra costs of the light and heavy vehicles alternative would be compensated for by extra revenues. Where the rate of return on the extra investment is acceptable, the dual-purpose road would be built.

12. The firm would be able to raise revenues from users because of the benefits that the road provided offered in comparison with existing facilities. Estimation of the revenues resulting from the acceptance of heavy vehicles would obviously include the revenue these vehicles themselves would pay. But as larger vehicles would also have important effects on the speeds of light vehicles as the road became congested, the estimates would also have to allow for the reduction in the benefits to light vehicles that heavy vehicles would cause and thus the lower price that light vehicles could be charged. Assuming, for convenience, that all benefits could be realised in terms of revenue by the road building authority, for the road to be built fit for heavy vehicles, benefits to them would have to be at least as great as the extra construction costs plus the loss of benefit suffered by other users from their use of the road.

13. But as well as deciding to invest, the firm must determine a charging policy. If the total benefits precisely equal total costs, then only one charging system is possible—that which will recoup all the benefits from each class. If total benefits were greater than total costs and the firm wished to maximise profits, it would charge what the market would bear. The limit to the charges would be the level of benefits experienced by users. If, however, benefits were greater than costs and the road authority was required, because it was owned publicly or controlled, only to cover costs, then several pricing policies would be open. Total revenues would, if prices were set according to what the market would bear, exceed costs; therefore price reductions below the maximum obtainable could be made. This could be effected in various ways—e.g. proportional reduction or special reduction for certain favoured classes.

14. This analogy has two important implications for the process of cost attribution. First, it emphasises the interdependence of investment and pricing decisions. In the example, the investment had to be justified in terms of the revenues that resulted. These in turn depended on, and could not be greater than, the total benefits created by the scheme. Knowledge of the benefits each class would receive precedes the decision about what shares of cost each vehicle class should bear, and benefits set a limit to charges. If the revenue required were greater than the total benefits, then the investment would not have been done. Consequently it would have been economic nonsense to attribute more of the cost to a vehicle class than the total benefits it received. If it were charged on this basis, it would not use the road and the investment should not have taken place in the form it did. If it did take place, the investment would prove uneconomic.

15. The second implication of the analogy is that where total benefits are greater than costs, it is not possible to determine precisely how much of a given investment a particular vehicle class may be said to cause. However

carefully the justification of expenditure is analysed, the problem of joint costs cannot be overcome. The size of the benefits indicates that the expenditure should be carried out for all traffic groups, but the surplus of benefits may be shared out in various ways. There is no single economic way of doing this. But again the attribution cannot be completely arbitrary: the limit set by the total benefit received by a vehicle class applies. There is a further limit on attribution though it is much more difficult to apply. It arises from the possibility of separate investment decisions by each vehicle class, as the following example illustrates.

16. Take a road costing 10 units which produces 10 units of benefit to light vehicles and 4 to heavy. Clearly, light vehicles must pay at least six for this road, otherwise it could not be financed, but it may appear they could be charged as much as 10, since this is the total of their benefits. But suppose they could invest in a similar road, of which they would have exclusive use, and from which they would therefore enjoy greater benefits. In this case, they would not be prepared to pay 10 units for the joint scheme, as they could be better off by investing in separate facilities. How much they would be prepared to pay, would depend on the nature of alternative investment opportunities. Car-only roads are not built in Great Britain though some exist elsewhere. But, in principle, it must be recognised that although a given scheme might be worthwhile, earning an acceptable rate of return, it might be more economic to spend the money differently, because an even better return could be obtained this way. If such roads are feasible, then, in principle, this further constraint on attribution for joint use roads applies.

17. To sum up: in order to attempt to determine what share of the total costs of capacity provision each vehicle class should bear the relation between capital expenditure on new roads and use of the roads by particular classes of vehicle may be analysed in terms of the benefits occurring from the expenditure to the particular class, since it is only these benefits which justify the commitment of resources. But because roads are joint facilities, it is not possible, even in this way, to determine precisely the share of the total cost that any particular vehicle may be said to cause. Equally, however, the shares are not completely arbitrary, since it makes no economic sense to attribute to a vehicle class more of the cost than the benefits they enjoy, and further limits are imposed where the possibility of separate provision for the various vehicle classes exists.

Capital costs and the use of roads within particular categories of heavy vehicles

18. Paras. 2–8 of this Annex gave estimates of the proportion of total road construction costs that could be attributed to the need to provide for heavy vehicles. This left open the question of the relative responsibility of these vehicles within the allocated total. Motorway and dual carriageway design is affected by heavy vehicles because of their extra weight and height, and their lower speeds on gradients. The first affects the carriageway costs, the second, bridge clearances, and the latter, earthworks.

19. Experimental work has been carried out in the United States to determine the required increases in carriageway thicknesses as axle loadings increase.[1] The relevance to British conditions of the relationships suggested by this work will be discussed below. Here the discussion will confine itself to the relevance of this type of information to cost attribution.

---

[1] See Annex 1

20. The relationships derived allow the increments of carriageway costs associated with increasing axle loads to be estimated above a basic road fit for light vehicles. In the Highway Cost Allocation Study, each incremental layer was shared out among the vehicles imposing the relevant axle loads.

21. The economic, as opposed to the engineering, meaning of this approach is not, however, clear. There is no reason why the process of determining increments for the purposes of cost allocation should not start at the other end of the scale, with the assumption that it was to be built for the relatively small numbers of the heaviest vehicles which impose every high axle loadings. This, of course, would be a very different road from the one that would be designed using the other approach. However, as progressively more goods vehicles imposing lighter, though nevertheless significant, loadings were taken into account, the optimal design of roads would change and would presumably finish up with a road identical to the one obtained by the first method. The increments, however, would be quite different. The increment of the light vehicles in particular (as they may be assumed to make up the majority of users) may even involve a change in construction methods and material used, since it is unlikely that, on economic grounds, it would be worthwhile building the same type of road for a few heavy goods vehicles as it would for light and heavy combined.

22. The incremental approach fails to make clear the inter-dependencies that exist between the various vehicle weight classes. The size of the extra increments depend on the fact that other increments have been added already. The consequence is that the incremental approach cannot be accepted as an approximation to an economic cost relationship; in particular it gives no guidance as to how the costs of the basic road for light vehicles only should be attributed to the different vehicle classes.

23. The problem here is very similar to that encountered with the attribution of capacity costs in Paras 9–17. The extent to which a particular vehicle class may be said to be responsible for carriageway strengthening cost may also be analysed in terms of the benefits accruing to it. In this context the major benefits are not operating cost savings, but the reduction in maintenance costs which the higher standard of road produces. If a few of the very heaviest vehicles only were to use a road, little capital would be invested in it, but maintenance costs per vehicle would be high. If vehicles of other weight classes use it, it becomes worthwhile investing in a more capital intensive structure, and this reduces the maintenance costs attributable to these very heavy vehicles. Thus, the level of maintenance paid by each vehicle weight group depends on the use of the roads by others. Therefore, as with capacity costs, a precise determination of cost responsibility for an individual vehicle cannot be achieved. Similarly, however, cost attribution is not for that reason completely arbitrary. There would be no economic meaning, for example, in attributing a level of costs to a vehicle category, if it would be uneconomic to expend that amount of capital to save the maintenance costs that would occur if it were not spent.

24. The second aspect, that of bridge heights, presents similar difficulties. The decision to build for certain clearances (assuming that this is not taken for other reasons e.g. defence requirements) depends not simply on the tallest

expected vehicles, but on the total number and type of high vehicle expected to use the road. If there are sufficient to justify the clearances, then certain expenditure decisions follow. The problem of attributing shares in this decision is exactly the same as for carriageway thicknesses.

25. The final aspect, gradients, is different from the other two, as this expenditure is in part undertaken for light vehicles which otherwise would be delayed by slow moving vehicles. If part of the justification for this expenditure is to be found in benefits to light vehicles, how can it be related to heavy vehicles? The obvious answer would appear to be to relate it to such factors as power-weight ratios, which will be the main determinants of speeds up gradients. However, this problem too can be analysed like the preceding ones. Slow moving vehicles reduce the benefits to other vehicles jointly using the road, and consequently, in terms of the analogy introduced above, when the decision to allow the former to use the road is taken (assuming for the moment that slow moving heavy vehicles can be separated out as a category), they should pay enough to compensate other uses for loss of benefit from their using the road. One way of doing this is for them to pay for the redesign of the road. If there are sufficient of these vehicles this is the appropriate way. If there are not, then it would not be worthwhile investing resources in reducing gradients or providing climbing lanes and either the vehicles should not use the road or the price to other users should be reduced and by implication the price or alternatively the proportion of cost attributed to the slow movers raised.

Maintenance Costs

26. Maintenance consists of a wide range of activities, which are not all related to use of the roads by particular vehicle types in the same way. Following the Geddes submission, four categories may be distinguished:

(i) Repair

(ii) Preventive maintenance

(iii) Miscellaneous work on drainage, kerb renewal etc.

(iv) Provision of signs, signals and road markings.

(i) Repair Costs

27. Repair costs are incurred where roads show signs of serious deterioration and the whole structure of the road is threatened. In the short term the road may have to be patched to make it suitable for traffic, but in the longer run it will be rebuilt. It is the former type of expenditure that is relevant here.

28. Apart from conditions on which climatic factors are so severe as to cause break up of roads on their own account, there is general agreement that heavy vehicles are responsible for most repair costs. They impose axle loadings many times those of light vans and private cars, and may quickly destroy structures which would give long and satisfactory service to the lighter vehicles. But there is considerable controversy about the relative responsibility for repair costs within the heavy vehicle class.

29. The major piece of experimental evidence available derives from the A.A.S.H.O. tests.[1] These tests, by far the most expensive and elaborate carried out in this field, were primarily engineering design studies aimed at discovering the best ways of building roads and related structures. The results were used to infer relationships between axle loadings and road wear. These implied that the relative responsibility for damage to the road surface increases in proportion to the forth power of the increase in the laden axle weight. The effect of a relationship of this kind is to attribute responsibility for repair costs to the heaviest vehicles almost exclusively.

30. This relationship is open to the criticism that can be made against all the A.A.S.H.O. findings—that they are not applicable to British or European conditions, since the physical circumstances in which the tests took place were very different to those obtaining here. The Ministry submission, although employing this relationship, pointed out that it had doubts about using it, endorsing the views of the then Director of Road Research: "Although it is of the utmost importance that the conclusions from this very large experiment should be utilised to the full in Great Britain, it is essential first to consider the results carefully in relation to British conditions. A major factor is the influence which frost had on the performance of the flexible pavements. The fact that 57 per cent of the failures occurred in the first spring thaw and 23 per cent in the second shows that the pavements were critically weak during these periods. So far as the axle loads are concerned, the A.A.S.H.O. experiment was an accelerated test, the concentration of axle loadings being 5–10 times that which will be present on a normal heavily trafficked British road. It is possible that many sections failed which would have survived the normal traffic concentration of a highway. This seems to be a basic weakness of the test and the method of weighting the applications of axle load used in the analysis does not appear to overcome the difficulty".[2] Elsewhere in Europe, A.A.S.H.O. ratios have been accepted, however: as Annex 18 indicates, the French have used it as the basis for their new axle tax.

31. Experiments on the scale of the A.A.S.H.O. tests have not been carried out in this country although related work is in hand at the R.R.L. It has to be accepted, however, that entirely satisfactory relationships for the repair costs occasioned by heavy vehicles are not available for British conditions. This deficiency has tended to obscure the fact that until recently very little information was available on the axle loadings imposed by heavy vehicles. It has generally been assumed that the heavier the vehicle, the higher the axle loadings. The evidence now available show that this is broadly true, but that the situation is more complicated than this assumption implies. Some evidence is presented in Annex 18.

---

[1] See Annex 1.

[2] More recently, the A.A.S.H.O. results have come in for a sustained attack on their significance from a panel of experts commissioned by the International Road Transport Union, who concluded that "the A.A.S.H.O. road test have not contributed positively to solving the problem of the apportionment of expenses between the various users of the road". Although the view is put more forceably, the factors stressed in that study were essentially the same as those quoted above. It is expressed in "Study and Research on Road Techniques and the Economy of Infastructures; analysis and interpretation of the A.A.S.H.O. Road Test", I.R.U., 1965.

(ii) Preventive maintenance costs

32. Preventive maintenance is carried out to anticipate the severe effect that high axle loadings can have on weak structures. Roads currently being built are designed so as to avoid this need but the older roads, not designed with modern traffic loadings in mind require surface work and, at times, foundation work, if they are not to break up. As with repair costs, there are no completely satisfactory data available on the relation between this type of expenditure and the passage of particular vehicles. As with repair costs, too, the important question is the relative responsibility of the heavier vehicles since it is clear that light vehicles have very little effect on all but the flimsiest of structures. In its Geddes submission, the Ministry suggested that gross weight would be the best approximation, but this was, and remains, only a matter of judgement.

(iii) Miscellaneous work on drainage kerb renewal etc.

33. This category is very mixed. Many items, e.g. work on drainage, hedge-cutting etc. are not related to volumes of traffic or particular vehicles. Others, e.g. kerb renewals, may be related to the incidence of commercial vehicles, but data are not available to allow the determination of any relationship. No data are available on the proportion of the total cost of this item incurred in the various component activities, but it is probable that the items which may be related to particular vehicles are relatively unimportant.

(iv) Provision of signs, signals, and road markings

34. This final item also covers a variety of activities. Some items are plausibly related to particular vehicles. Road markings for example, are obliterated largely by wear and as heavier vehicles tend to have more axles and wheels, it is reasonable to assume that they are responsible for more sign obliteration than other vehicles. Sign cleaning and maintenance might also be related to the passage of heavier vehicles and to the volume of traffic. The larger vehicles throw up more dirt and hence necessitate more frequent cleaning and it is possible they cause more damage to signs, but data are not available on either of these relationships, nor is it possible to estimate the proportion of this category made up of these various activities.

Policing

35. As explained in the Notes on Tables, it is only recently that detailed information has become available on the proportion of police costs associated with traffic. There is little information available that would indicate how, if at all, police costs relate to the use of roads by particular vehicles. In the Notes on Tables it is pointed out that police forces surveyed in summer showed a higher proportion of police time devoted to traffic duties, which implied that this responded to holiday traffics, which consists of light vehicles. There is no comparable information on daily peaks, but it is clear that the conditions of peak traffic do necessitate the greater attention of police for traffic duties. Consequently light vehicles which tend to form a higher proportion of peak traffics may be held to be particularly responsible for this use of police time.

36. Police time is also spent on patrolling roads and dealing with accident consequences. The former is concentrated on main roads, for obvious reasons. A motorway may cost up to £1,000 per mile per annum to patrol while lesser

roads will scarcely be covered at all except when accidents occur. The intensity of patrolling would appear unrelated to vehicle type. Time spent on the consequences of accidents clearly is so related, but it is not known how it is related to particular types of accidents; e.g. fatal accidents, which heavy vehicles are more frequently involved in than cars, might be more expensive in terms of police time.

Lighting

37. The convention adopted in the Geddes submission which is followed here was that only lighting on main roads should be charged to road users, as lighting in residential areas may be said to be primarily for the good of pedestrians. On urban main roads, high standard lighting is frequently provided where flows are high, but in rural areas has been installed only on relatively short sections, mainly motorways. It is clear these costs cannot be related to a particular vehicle class.

Administration

38. Only a very small part of these items may be related to vehicle types e.g. that part associated with road haulage licensing. Most of it is related to the levels of expenditure on the items discussed above, or to traffic in general.

ANNEX 16

(a) Fuel tax, vehicle excise duties and purchase tax as charging mechanisms

1. As indicated in Chapter 2, fuel and purchase taxes and vehicle excise duties are important revenue raisers and economic regulators. This Annex however, will ignore these functions and consider in detail the point made briefly in Chapter 5 that vehicle excise duties and fuel and purchase taxes are imperfect mechanisms for charging purposes.

2. Apart from a number of minor fees and charges, revenue is raised from road users in three ways: through fuel tax, vehicle excise duties and purchase tax. All three are fairly efficient as revenue raisers. Fuel and purchase taxes are easy and cheap to collect, and are, in general, almost impossible to evade. The vehicle excise duty is evaded by a small minority of road users, currently estimated at between 1 and 2 per cent, and it costs about £7m. per annum to collect.[1] However, the need for some sort of registration structure exists independently of the existence of charges. It would be necessary for other purposes of which perhaps the most important are the requirements of the police, and the need to maintain a record of vehicle ownership. Consequently, the cost of raising revenue in this way is small in relation to revenue raised and the other benefits of the system.

3. All three taxes, then, are good from the point of view of revenue raising and administrative convenience. They have rather different economic characteristics. These are examined in turn below.

4. *Fuel Tax*

Fuel taxation has three important characteristics:

(1) it is paid with each mile travelled.

(2) it varies with the nature of the vehicle.

(3) it varies with the speeds at which vehicles travel.

5. All three of these characteristics are useful attributes of any charging system for roads. The amount paid varies with the use made of the system: the heavier vehicles, which impose extra costs, pay more than light vehicles, and in a situation where roads are congested and speeds low, fuel consumption rises, and with it, the tax yield.

6. At the same time, however, the fuel tax suffers from severe deficiencies. Its main drawback is that, although it tends to vary with public and community costs in a number of situations, in others it either fails to do so, or does so imperfectly. In addition, the tax varies where there is no reason, from the point of view of road costs, that it should. Private cars, for example, have quite different average fuel consumption rates, that reflect only different technical and performance specifications.

---

[1] 2½ per cent of the amount collected in 1965.

7. The main cost variations that are not reflected adequately through fuel tax are:

(1) variations in the costs of road provision from one part of the system to another;
(2) variations in the level of congestion costs both from one part of the system to another, and between time of day;
(3) variations in the costs imposed, or the benefits received, by particular vehicles.

8. From some points of view these are not serious deficiencies. The system of long run marginal cost pricing discussed in the Report for example, must inevitably embody a considerable degree of averaging both between vehicles in a given class and between classes. As long as the inequities are not gross, the fuel tax may be a satisfactory charging mechanism in this context, and, if it fails, it may be supplemented by excise duties. However, any system of charging that requires a close relation between charges and cost, such as short run marginal cost pricing, is unworkable, if the fuel tax alone has to be relied on. Fuel consumption and consequently fuel tax paid do vary according to congestion, but the extent of these variations is much less than the range of congestion costs that are encountered, which if they were to be covered by fuel tax, would imply levels of fuel consumption unattainable by ordinary cars even in the worst traffic conditions. Similarly, any workable discrimination between vehicle types on the basis of the costs they impose in wear and tear and congestion is impossible, unless the charges desired happen to coincide with the pattern that the fuel tax achieves. The pattern of incidence that the fuel tax achieves as between even broad vehicle classes cannot be that which either of these cost items would suggest for each and every part of the network.

9. *Vehicle excise duties*

Vehicle excise duties were originally introduced to supplement the fuel tax and in particular to allow a steeper incidence of taxation by weight than the fuel tax alone allowed. Their main feature is that although they allow vehicles to be taxed on some additional aspects of cost variation, they do not relate to the use actually made of the road system as the burden of the duty is felt more heavily by those who make little use of it and more lightly by those who use the system intensively.[1] The extent of this distortion depends on how great the mileage disparities are between users in a particular duty bracket. Very little is known about the variations in the number of miles run with given vehicle group or weight class so that little indication of the range of effective incidence of excise duties can be given.

10. If vehicle excise duties bear little relation to use made of the system, still less do they mirror any costs, like those caused by variation in terrain, that vary from one part of the system to another. They fall the same on each mile run by a given vehicle, and users in all parts of the country pay precisely the same.

11. *Purchase Tax*

Purchase tax is levied on the sale of new cars and motorcycles, but it affects second hand prices indirectly by increasing their relative attraction. It is in no way related to any of the factors which might be considered relevant to charging.

---

[1] Certain vehicle classes, e.g. showmen's vehicles, do, however, enjoy reduced rates on the grounds that their annual mileages are much below average.

(*b*) Some alternative charging methods

1. The methods currently used to tax road users are not the only means available for charging for roads. The purpose of this part of the Annex is to consider some alternative possibilities that do not need the technical development that road pricing requires.[1]

Vehicle mile taxes

2. The basic principle of a vehicle mile tax is that it is levied on the actual mileage travelled by a vehicle, including empty running, while the actual rate of tax could be made to vary with whatever characteristics of the vehicle appeared most relevant. It would in this way combine some of the advantages of the fuel tax and excise duties. It could be levied in principle on all vehicles, but it is usually assumed that it would apply only to commercial vehicles and perhaps buses, since the administrative difficulties of including the much larger number of cars would be considerable. As it is, extra costs would have to be incurred to ensure that an accurate record of vehicle mileage was available for charging purposes.

3. It would not be administratively feasible to use a tax of this sort to reflect conditions on particular roads, either congestion or differences in maintenance costs. Consequently, its use would preserve the broad averaging which is a central feature of the fuel tax. The main case for such a tax would be the failure of the fuel tax and excise duties to combine together to reflect a particular important aspect of road cost, for example, wear and tear on the road surface. But although a mileage tax might have some advantages in that it would be easy to produce the degree of progression desired with unladen weight or other tax base, they would not be great, since the fuel tax and excise duties combined could, if required, be used as a reasonable approximation to any chosen scale. Such advantages would, of course, have to be set against the far greater costs of administration and collection, which would be considerable in this country as no suitable structure exists, except for abnormal loads.

4. An alternative form of this tax is based on the ton miles a vehicle performs, or the carrying capacity of the vehicle. There may be two reasons for using this method; first it may be thought to be an approximation to wear and tear on the road surface—in fact as Annex 15 shows this is unlikely to be the case: second, it may be thought that the larger vehicles in some sense benefit more than the smaller or alternatively that they are better able to bear a given level of tax.

5. Although there are grounds for thinking that the benefit of road improvements may be greater for heavier commercial vehicles than light, there is no reason to think that the difference bears a close relation to gross vehicle weight. Nor is it obvious that gross vehicle weight is a good measure of ability to bear taxes. The cost per ton carried is greater for smaller vehicles than for light. Consequently a charge related to tonnage carried would have a greater relative impact on the larger vehicles. Furthermore, the possibility of alternative forms of transport is more real for the goods carried by the larger vehicles. The notion of ability to pay is in any case quite different from the notion of charging according to costs incurred, and the former would seem inappropriate for roads, which are not commercially organised.

---

[1] For systems designed for the urban context see: Better Use of Town Roads.

Tolls

6. *Prima facie*, a system of charging for roads by tolls is attractive, since it would enable charges to be related to the conditions on particular parts of the system (in particular to different levels of congestion and road maintenance costs) and to the costs imposed by particular vehicles. But given the currently available means of charging tolls—toll booths—such a system would in practice have to be confined to a small number of roads, since the cost of collection and the costs of delays to road users would be excessive. In this country, probably only the motorway network, with its limited number of access points, could be charged for, and even then at unwarranted expense. Apart from the costs of collecting the tolls, their effects on the utilisation of the road system would be harmful. They would tend to discourage the use of the motorway system, which at current levels of loading has no justification, since the marginal costs of use are extremely low, and lower than the costs on competing roads. Clearly, too, because of their limited area of application, the amount of revenue that could be raised would mean that they could only be a supplementary form of charging and not a replacement for the forms currently employed.

Conclusion

8. The alternative methods of charging that are currently available appear to offer very little that cannot be achieved by the existing means without very considerable additional costs.

ANNEX 17

The long run marginal cost of road provision

1. Long run marginal cost (L.R.M.C.) is defined as the extra cost of providing for an extra unit of output when all costs are allowed to vary: thus it differs from short run marginal cost because it includes all cost categories but resembles it because it ignores all costs that have been incurred in the past.

2. L.R.M.C. is peculiarly difficult to define for roads for two reasons. First, conditions vary over the network. As demand is spatially specific, L.R.M.C. at particular parts of the network should be estimated. Thus there is in no simple sense a L.R.M.C. of the road system. Second, old capital rarely, if ever, goes out of use because of the provision of new. The road network is never completely renewed, consequently all additional investment is a modification of the existing capital stock. The strict conditions for the definition of L.R.M.C. therefore do not obtain, only the costs of providing extra capacity given the existing capacity can be examined.

3. These two points suggest that for roads a modification of the concept of L.R.M.C. should be used, but one which will preserve the essential purpose of this pricing system, that of presenting users with the future rather than the past costs of road provision. A possible approach is the following. First assume some distribution of the increase in demand over the network and then derive a cost of expanding capacity as required at various parts of the network. On most parts of the network (measured in terms of mileage) the cost will be zero. On these there is, and will be for the conceivable future, spare capacity. This is broadly true of the less important classified and unclassified rural roads, whereas on the trunk network considerable investment is and will be taking place. Here the costs will be high.

4. If this approach is adopted, the sum required of road users as a whole will tend through time to equal the sums actually spent on roads as a whole, even though, because of the deficiencies of the existing charging mechanisms, they will not do so for any particular type of road. Consequently, in this Report current expenditure has been regarded as the appropriate method of defining L.R.M.C. for roads.

ANNEX 18

Data on axle loadings

Weighbridge Data

1. These data were collected in the course of experiments with various vehicle weighing devices, which were carried out in preparation for the introduction of the goods vehicle plating system. They were collected at sites on four main roads near London during daylight hours during the first three months of 1967. About 2,200 vehicles were weighed.

2. The vehicles chosen were not a random sample of the flow past these points and it is clear from the nature of the points themselves that the data could be subject to serious bias. They could not be used, for example, to infer anything about the extent of overloading on the road network as a whole. It is not obvious, however, that the sample should distort the relativities between vehicles. It is, in any case, the only information available at this level of detail.

Road Research Laboratory Data

3. These data are part of a long run continuous measuring programme over a large number of sites, which is still in operation. The apparatus used records all axles passing (above a minimum weight level) but only records (by means of a photographic device) details of the vehicle, when the maximum permitted axle load is exceeded on one axle of the vehicle. The photograph allows the vehicle type to be identified and sometimes its load, as well as the time of day, but no other details. Some results are shown in Road Research 1965/66[1].

Overloading Offences

4. Details of overloading offences over a period of a year in the Northern Traffic Area were analysed. These provide data on the unladen weight of the vehicle concerned, loads, body type and size of the operator's fleet. They cannot be regarded as a random sample. The results have not been published.

The significance of these data

5. One broad point that emerges from all these sources is that it is by no means the heaviest class of vehicle which frequently impose very high axle loads. They begin to occur above three tons unladen weight and are frequent in the 4–5 ton class. The weighbridge data, however, allow this broad trend to be analysed more closely.

6. Tables A18 : 1 and A18 : 2 analyse the axle loadings obtained by the unladen weight of the vehicle and the number of axles, the first Table showing the actual load in tons, the second the implied load when the axle loads measured are raised to the fourth power. Tables A18 : 3 and A18 : 4 convert these two Tables into total vehicle loadings on the two bases. Two trends are apparent. First, on both bases average load per axle rises as unladen weight increases: second, for a given unladen weight group the fewer the number of axles, the higher the

---

[1] Road Research Laboratory "Road Research 1965/66" HMSO 1967.

average load per axle. The effect of applying the 4th power law is to highlight this tendency. While for a given unladen weight class the gross loads of the vehicles with fewer axles are almost invariably lower, the weighted and unweighted loads per axle are much higher. It is only when the power law is applied, however, that the vehicles with fewer axles are judged to have a greater *total* affect on road wear (i.e. allowing for the fact that while axle loadings are lower for vehicles with more axles, they have more of them). The effect on relative weighting between unladen weight groups of applying the 4th power law is much less important. The relation between the 3–4 ton vehicle and the 4 axled vehicle heavier than 9 tons unladen is changed only from 3·8 : 1 to 2·2 : 1, and the effect of the weighting on the relation between the 2 axled vehicle in the 4–5 ton group and the 4 axled vehicle in the top weight class is to reduce the range.

7. The most important implication of these data is that the unladen weight of a goods vehicle is not an adequate guide to the loads it imposes, but that the effective wear and tear on the surface relates to the number of axles it possesses, over which the load is spread. The stronger the weighting attached to increases in axle loadings the greater the difference that is created between vehicle types of the same general weight class but with different numbers of axles.

8. In France similar considerations have led to the introduction of a new tax, which relates specifically to axle numbers, so that a four-axled tractor and semi-trailer of a given capacity will pay much less than a three-axled combination of the same capacity. A five-axled combination will not pay the tax at all.

9. It has already been indicated (see Annex 15) that there are reasons for thinking that the A.A.S.H.O. results, which the French used to estimate the relative costs of different types of vehicle, bear too heavily on the heavier axle loads in British conditions. Consequently the case for an axle load charge is somewhat less strong here. And in any case, it would be impracticable to institute one until the widespread application of vehicle plating which will allow vehicles to be classified according to characteristics other than unladen weight.

TABLE A.18: 1

Heavy goods vehicles: axle loadings in tons by unladen weight group and number of axles per vehicle; arithmetic averages

Unladen Weight in tons	*Tons per axle* *No. of axles*		
	2	3	4
3–4	4·2	—	—
4–5	6·2	4·6	—
5–6	6·1	5·0	—
6–7	—	5·4	5·0
7–8	—	6·1	5·1
8–9	—	7·2	5·2
9+	—	—	5·8

TABLE A.18: 2

Heavy goods vehicles: axle loadings in tons by unladen weight group and number of axles per vehicle, weighted by A.A.S.H.O. 4th power formula

Unladen Weight in tons	*No. of axles*		
	2	3	4
3–4	1,225	—	—
4–5	2,714	1,206	—
5–6	3,590	1,334	—
6–7	—	1,777	1,797
7–8	—	2,848	1,861
8–9	—	4,855	2,022
9+	—	—	2,357

TABLE A.18:3

Heavy goods vehicles: gross weights in tons by unladen weight group and number of axles per vehicle

Unloden Weight in tons	Number of Axles 2	 3	 4
3–4	8·4	—	—
4–5	12·4	13·8	—
5–6	12·2	15·0	—
6–7	—	16·2	20·0
7–8	—	18·3	20·4
8–9	—	21·6	20·8
9+	—	—	23·2
	as above: Index form		
3–4	50	—	—
4–5	77	85	—
5–6	75	93	—
6–7	—	100	123
7–8	—	113	126
8–9	—	133	128
9+	—	—	143

TABLE A.18:4

Heavy goods vehicles: total axle loadings in tons (A.A.S.H.O. weighted) by unladen weight groups and number of axles per vehicle

Unladen Weight in tons	Number of Axles 2	 3	 4
3–4	2,450	—	—
4–5	5,428	3,618	—
5–6	7,180	4,002	—
6–7	—	5,331	7,188
7–8	—	8,544	7,444
8–9	—	14,565	8,088
9+	—	—	9,428
	As above: Index form		
3–4	46	—	—
4–5	102	68	—
5–6	135	75	—
6–7	—	100	135
7–8	—	160	140
8–9	—	273	152
9+	—	—	177

ANNEX 19

Theory of differentials between heavy goods vehicles

1. If choice between different types of heavy goods vehicle is not to be distorted, it is the differences between the absolute costs of providing for different types which should be reflected in charges. It is necessary first of all to consider those costs which vary with the type of vehicle. They are extra construction costs relating to such factors as weight, height and speed, extra maintenance costs, relating mainly to weight, and extra congestion costs, relating to speed and manoeuvrability. The assumption behind this Annex is that each vehicle within a vehicle class experiences a reasonable cross section of road conditions. To the extent that this is true (there are, however, no data currently available that would confirm or refute it), then it is meaningful to differentiate between vehicles in annual charges. The next section discusses the different cost items which justify differentiation.

2. Extra construction costs on new roads, and improvements to existing ones, are needed because heavy goods vehicles apply heavier weights to the surface and are taller than other vehicles (except buses); they also have lower running speeds on gradients. The first factor is clearly directly related to weight, the other two only indirectly. Relationships have been derived in the United States between vehicle weight and construction cost but these are, for two main reasons, not precisely what is required. First, they were derived from experiments in conditions dissimilar from those obtaining in this country and secondly, these relationships show the extra increments of thickness appropriate for increasing axle loads. It is not easy to attribute these increments of cost to particular vehicle types, both because there is no close correlation between individual axle loadings and other vehicle characteristics such as weight, and because there remains a problem of sharing out a particular increment between the vehicle in a particular axle loading group, which it is not possible to do in such a way as to charge each vehicle an amount that would equal the resources saved were it not to use the road. The main difficulty is that to some extent the various cost increments are inter-related; the size of the increment necessary for the heaviest axles, for example, depends on the assumption that the other increments have already been laid down[1]. The same problem arises with the question of vehicle clearances; while it is clear that only the very tallest vehicles necessitate the highest clearance and it is appropriate to charge them this increment, it is not clear what share they should have in the lesser increments which are necessary for them and for smaller vehicles. A similar argument applies to the cost of reducing gradients.

3. These complexities suggest it would have little economic meaning to share these costs out between vehicles, since the relativities obtained could not be said to reflect true relative costs even in principle. Unlike the other two categories of cost, they are of a capital nature and do not vary with the miles run on the system. There is, therefore, a case for concentrating on the short run costs alone exactly the same as that outlined in Chapter 5 of the Report paras 59-62, and this view will be adopted here. The relevant short run costs are surface maintenance and congestion.

---

[1] See Annex 15.

4. The relative responsibility for surface maintenance costs, as was mentioned above, has been most thoroughly investigated in the United States. It is clear, however, that, even if the relationships derived are extreme for British conditions, the true relationships (which will, however, differ from road to road) will be a power function. Table A 19:1 shows the differentiation that the application of different relationships would suggest between different weights of heavy vehicle. As Annex 15 makes clear, it is not at present possible to determine which is the most appropriate.

5. The second item is congestion. To reflect a congestion element in charges on goods vehicles is not the same as charging for congestion, as outlined in paras. 59–62, nor would it produce the same level of charges as a road pricing system, for all that it is relevant in the present context is the difference between heavy goods vehicles, and not the absolute amount of congestion they cause. The relative responsibility for congestion is, however, difficult to establish with precision. A good deal of work has been done, both in this country by the Road Research Laboratory and elsewhere, on the relative effect of different categories of vehicle on speeds in different road conditions. This work has concentrated on broad vehicle classes, and not on small groups such as particular vehicle weights. However it is fairly clear that factors causing congestion are related to vehicle weights. The speeds of the heavier vehicles are on average below those of medium sized, and these in turn below the lightest class. On many roads it is the speed of the slowest vehicle which determines overall speed. Also, manoeuvrability and acceleration decrease with weight, and increases in length make overtaking more difficult. These factors all suggest that relative congestion costs increase with weight, although there will be some variation due to other characteristics such as power/weight ratios, which cause variations within a particular weight group. For example a statistical analysis of main road trunk flows carried out by S. Wabe[1] has suggested that traffic speeds are largely determined by a few slow moving vehicles, not all of which will be in the heaviest weight classes. However, there is no way of determining precisely what the relation is, and it may be that the differentials within weight groups are large enough to justify a different way of classifying vehicles—e.g. by power/weight ratio or body type.

6. If the right relativity between vehicles were known, it would be necessary to estimate the absolute amount of congestion caused on average by each to set it against the estimates of relative maintenance costs. In rural areas, the additional amount of congestion caused by a heavy vehicle is fairly small—an estimate of less than 1d. per mile[2] has been obtained from estimating the effect on flow of removing a vehicle at a number of rural census points, and averaging the results. But this figure is of course typical only of part of the network; in urban areas a congestion cost measured in the same way would be much higher, which suggests, if this were the right relation between vehicle weight and congestion, a much greater differential between vehicles, at the top

---

[1] S. Wabe: "A measure of congestion and the speed of traffic on trunk roads" (unpublished).

[2] This is an average figure; some vehicles impose much higher costs. Work done at the Road Research Laboratory indicates that congestion costs for very large vehicles are very much higher than the figure quoted here. This would seem to indicate that these costs rise very steeply when the normal vehicle size and weight limits are exceeded.

and bottom of the weight range. At the moment it is impossible to say whether the assumption that congestion effects are in direct proportion to vehicle weight is right or not. If road pricing proves technically and administratively feasible then it will be necessary to attempt to measure the differential.

7. In summary, therefore, it is not possible at the moment to be confident what the true differential between vehicle weight groups should be on economic grounds. Although present estimates of maintenance costs are uncertain, an equally important lack of knowledge is the relative congestion effect of different weights of vehicles on other road users, since especially in urban areas, the absolute level of these costs may be as high as maintenance costs, even on a road expensive to maintain.

TABLE A.19:1

Estimated relative wear and tear costs per heavy goods vehicle on various bases.

Cost per vehicle mile

Unladen Weight in tons	*Gross weight*	*Cubing (3rd power law)*	*AASHO (4th power law)*
1½–2	18	9	2
2½–3	35	24	14
3 –4	56	45	36
4 –5	68	63	71
5 –6	84	77	71
6 –7	100	100	100
7 –8	116	113	114
8+	134	140	156

Cost per vehicle per annum

Unladen Weight in tons	*Gross weight*	*Cubing (3rd power law)*	*AASHO (4th power law)*
1½–2	7	3	1
2 –2½	9	5	2
2½–3	12	8	5
3 –4	32	26	21
4 –5	53	50	56
5 –6	68	61	58
6 –7	100	100	100
7 –8	123	120	121
8+	147	155	173

Tonnage Group 6—7 tons=100

NOTES ON TABLES

List of Tables

Table		*Page*
2.1	Road cost categories	4
3.1	Public road costs 1965/66 Current Expenditure Basis	10
3.2	Public road costs 1965/66 Public Enterprise Basis	10
3.3	Public road costs 1975 Current Expenditure Basis	12
3.4	Public road costs 1975 Public Enterprise Basis	12
4.1	Revenue raised from road users 1965/66	13
4.2	Revenue raised from road users: estimates for 1975	14
5.1	Maintenance costs by type of road	19
5.2	Marginal public costs	20
8.1	Total revenues (fuel tax and excise duties only) contributed by major vehicle category 1965/66	30
8.2	Total public costs allocated to each major vehicle category 1965/66	30
8.3	Revenue/cost ratios by major vehicle category 1965/66	32
9.1	Vehicle fleet 1965	33
9.2	Revenue raised by applying car revenue/cost ratio to heavy goods vehicles, 1965/66	34
9.3	Revenue/cost ratios by vehicle class assuming road haulage charge in force 1965/66	34
9.4	Tax paid by heavy goods vehicles by unladen weight category (excise duties and fuel tax) 1965/66	35
9.5	Revenue/cost ratios for heavy goods vehicles before payment of road haulage charge 1965/66	35
9.6	Revenue/cost ratios for heavy goods vehicles after notional payment of road haulage charge 1965/66	36
A5:1	Passenger car equivalents	65
A5:2	Passenger car equivalents of trucks on ordinary multi-lane highways	66
A5:3	Vehicle miles on all roads in Great Britain	67
A14:1	Numbers of general goods vehicles currently licensed 1960–66	92
A18:1–4	Axle loadings of heavy goods vehicles	109
A19:1	Estimated relative wear and tear costs of heavy goods vehicles	113

Table 2: 1 Road cost categories

This Table is not intended to be an exhaustive list of cost items, but rather to be illustrative of the categories suggested. Items have been included at the point of immediate impact. For this reason, congestion does not appear explicitly: it is contained in user costs—time and operating expenses. The same cost item may appear under all three headings. For example, accident costs fall on road users, the state and the community at large. Time is included as a cost whether or not it is paid for. Time spent on a journey to work, for example, may be considered a cost, since it could be used for other purposes.

Table 3: 1 Public road costs 1965/66 current expenditure basis

This Table is derived from several sources. Items 1, 2, 3, and 4 are adapted from the figures published in Highway Statistics 1966. The figures as published there contain a certain amount of central government administrative expenditure. This has been taken out and included in Item 7. The split between maintenance and minor improvement expenditure is based on internal Ministry statistics and is only approximate. Similarly there can be no precise dividing line between major and minor improvements: some small schemes included in major improvements are very similar in nature to many classed as minor improvements, and have been similarly treated for the purposes of cost allocation.

Item 5 is intended to apply to main roads on the ground that the bulk of other lighting costs are incurred on behalf of pedestrians. It includes trunk road lighting and a small proportion of other lighting costs, estimated from unpublished figures.

Item 6 is based on figures derived from the survey carried out by the Institute of Criminology, University of Cambridge, the preliminary results of which were published by the Select Committee on Estimates.[1] A more detailed discussion of the subject will be presented in the forthcoming book, "The Cost of the Police in England and Wales", by Professor J. P. Martin and Miss Gail Wilson, who kindly supplied the information on which the estimate shown in the Table is based. The survey obtained details from a number of police forces of the break-down of their members time between different types of duty. The proportion of time spent on traffic duties for forces surveyed outside the holiday season ranged from 17·6 per cent to 28·9 per cent for provincial forces, with an average of 22·7 per cent. The three forces resurveyed in summer returned somewhat higher figures. The proportion of time spent on traffic duties was assumed to be a fair representation of the proportion of current costs devoted to traffic. Accordingly the time shares were applied to figures for current police expenditure by county boroughs and county council authorities, the higher summer figures being assumed to apply for four months of the year. Capital expenditure on items other than vehicles was treated in the same manner. These were all assumed to be incurred on traffic duties, which clearly is an overstatement but not an important one.

Item 7 is composed mainly of local government expenditure, as shown in Highway Statistics, but it also includes a number of other items, in particular a share of the Ministry of Transport expenditure on salaries and general administrative expenditure, and items G, H, I, L, M, N, O, P, in the Roads (England) Vote together with the corresponding items for Scotland and Wales. This includes certain research expenditures as well as central administrative expenditure.

---

[1] House of Commons: First Report from the Estimates Committee, Session 1966/67, Police. H.M.S.O., 1967.

Item 8; the calculation of this item is explained in Annex 12.

All items refer to the financial year 1965/66.

Table 3:2 Public road costs 1965/66 public enterprise basis

This Table is identical with the previous one except that "Capital charges" has been substituted for the first two items. The derivation of this figure is explained in Annex 13.

Table 3:3 Public road costs 1975: current expenditure basis

The low estimates have been obtained by assuming that all items except capital grow at the same rate as traffic. In the case of capital, account has been taken of figures already announced for 1970–71, but no growth in the 1970's has been assumed.

The high estimates have been obtained by employing similar arbitrary assumptions. The capital expenditure has been assumed to grow between 1970 and 1975 at a rate of three times the rate at which traffic is expected to grow during the same period. The estimate for accident costs does not take account of the recent policy measures. It is simply a projection of recent traffic and accident trends, allowing for changes in traffic composition. All the other items are assumed to grow from 1965 to 1975 at the same rate as traffic over this period.

Table 3:4 Public road costs 1975 public enterprise basis

All items except capital are the same as Table 3:3. The capital figures have been obtained by up-dating the capital stock estimates used in Table 3:2 in line with the expenditure assumptions used in Table 3:3.

Table 4:1 Revenue raised from road users 1965/66

The fuel and purchase tax figures have been derived from the Annual Reports of Her Majesty's Customs and Excise. They have been adjusted to take account of purchase tax paid on cars registered in Northern Ireland, fuel used in Northern Ireland and fuel used for purposes other than road use (e.g. off-road motorised vehicles). Allowance has not been made for tax repayments under the fuel rebate scheme for public service vehicles. Figures for vehicle excise duties have been derived from internal Ministry of Transport sources. The total for these duties given here contain receipts from vehicle classes, e.g. tractors, which do not figure in the rest of the Report. In all, these miscellaneous classes pay about £6m. Some small revenue items e.g. driving test fees have been omitted. Expenses associated with them have also been omitted from the expenditure account. Revenue and expenses associated with parking have been ignored, as have also the proposed fees for the carriage of large and heavy loads, as these only concern a small and very specialised group of vehicles.

Table 4:2 Revenue raised from road users: estimates for 1975

These estimates were obtained by applying current tax rates to the expected vehicle fleet structure in 1975. See Annex 14.

Table 5:1 Maintenance costs by type of road

These figures have been derived from unpublished Ministry of Transport data; they refer only to English Roads, and include only short run costs.

Table 5:2 Marginal public costs

An attempt has been made in this Table to pick out those items of cost which could be termed the running or current costs of roads. A small portion of lighting and police costs have therefore been excluded as they comprise capital items. Part of what is termed maintenance for statistical purposes is of a capital nature in that it improves the long term wearing capacity of the roads but it is not practicable to determine how much. The administrative costs that are most likely to be related to road use in the short run, i.e. those concerned with driving tests and registrations, have been in any case excluded from the administration figure so no part of this item has been shown. Part of administration costs is, however, concerned with cleansing and lighting expenditure and should, perhaps, be deemed current but it is not possible to say how much.

It can be argued that part of capital should be accounted a marginal cost. For example, if a road is worn by the passage of an axle, no expenditure is currently incurred, but the need for future expenditure is brought forward. This is equivalent to counting physical depreciation of any asset as a current cost. If this view is accepted, the total in the Table should be increased to allow for the capital expenditure brought forward. This is the difference between the present value of two capital sums. As the expenditure is likely to be infrequent, this will not be a large sum.

Table 8:1 Total revenue (fuel tax and excise duties only) contributed by major vehicle category, 1965/66

Estimates of receipts from vehicle excise duties have been obtained, classified by vehicle class from Ministry of Transport internal sources. Estimates of the yield from fuel tax are more difficult to make and more liable to error. Firm figures exist for part of road use by public service vehicles because of the operation of the fuel tax rebate scheme. This, however, only applies to stage services. The contribution of other bus services have been estimated pro rata according to mileage run on non-stage services. Estimates of tax paid by commercial vehicles have been derived from a Ministry of Transport Survey of Operating Costs which provided information both on fuel consumption per mile and on mileage run. No information was available for motor cycles so an arbitrary figure of ½d. per mile was assumed. Revenue from cars emerges therefore as a residual, but it has been checked against published sources. This Table does not include purchase tax for the reasons given in Chapter 2. Motor cycles have been omitted from this and subsequent Tables because of the uncertainties attached to estimating the revenue they pay, the costs to be allocated to them, their current importance and continuing decline. Allowance has, however, been made in both the costs and the revenue calculations.

Table 8:2 Total public costs allocated to major vehicle categories 1965/66

The allocation methods employed to produce this Table follow very closely those used in the Ministry submission to the Geddes Committee. Detailed justification can be found in Annex 15. Here only a brief statement, without justification will be made.

(*a*) **Capital costs including minor improvements.** As in the Geddes submission a part of capital costs has been allocated to heavy vehicles exclusively, 15 per cent in the case of major capital works and 20 per cent in the case of minor improvements. Annex 15 indicates why these proportions have been used. The remaining capital expenditure has been allocated by weighted vehicle miles. In the earlier submission, p.c.u. values were used for weighting the various vehicle mile figures, but in this Report lower values have been used, heavy vehicles being weighted only twice as much as light: motor cycles have been given the weight of one half of cars. There are several reasons for thinking that the values used in the earlier submission bore too heavily on heavy vehicles. First, although the p.c.u. equivalences were those derived for rural roads they were not obtained on roads of the type currently being built, motorways and dual carriageways. The former are not subject to speed limits and traffic conditions are considerably different, in particular, heavy commercial vehicles are not subject to the 40 m.p.h. limit. There is a *prime facie* case for suggesting, therefore, that the p.c.u. equivalences might not be representative for the bulk of current expenditure on new roads and major improvements. Second, average speeds of all vehicle classes have tended to rise with time as performance has improved and there is some evidence[1] that the gap in performance between the very heavy and the medium commercial vehicle is closing, which would imply some diminution in the range of p.c.u. values. Third, for a good part of the life of a new road, the p.c.u. equivalences are not relevant since the road is uncongested. In terms of the benefit/cost analysis, this reflects the fact that in the earlier years of a scheme's life, light vehicles are virtually unaffected by the presence of heavy vehicles and consequently do not need to be compensated for their using the facility. Fourth, the simple use of p.c.u. equivalences ignores the significance of peak hours volumes as determinants of the timing of investment. Peak flows almost without exception contain a higher than average proportion of cars and it might therefore be appropriate to take this into account when deriving a weight for heavy vehicles. Fifth, urban values have a smaller range than rural.

All these points suggest that the use of rural p.c.u. factors alone is likely to attribute too high a share of total capital costs and consequently some modification to take into account the points made above should be affected. However, it would appear too extreme to treat commercial vehicles on the same basis as lighter vehicles, since their presence on the roads brings forward the case for new investment more than in proportion to their numbers. For these reasons therefore a weight of 2 for heavy vehicles has been employed.

Maintenance: this item also has been divided into two parts; that concerned with the surface: repairs, patching and surface dressing, and the rest consisting of sign cleaning, hedge cutting and other miscellaneous items. Heavy vehicles have been allocated nearly all of the former category of cost while all vehicles have been treated equally for the remainder i.e. costs have been shared out by vehicle miles run on each class of road. Repair and surface maintenance costs on all but classified roads have been exclusively allocated to heavy vehicles, (which is a slight but insignificant overstatement), while on unclassified roads, these costs have been shared out on a vehicle mile basis. In the earlier submission no such costs were allocated to heavy vehicles on this class of road, because of their low level of usage. Their share is not, however, inconsiderable so in this Report some allowance has been made. It would not, however, be reasonable to allocate all these costs to them because many unclassified roads will be scarcely worn out at all by heavy vehicles, as their use of them is so infrequent. The allowance suggested—according to their share in vehicle miles run on these roads—is arbitrary.

---

[1] See Road Research, 1965/66.

All other items except accident costs not covered by insurance: These have been allocated on the basis of vehicle miles run on each kind of road. The alternative method of allocating police costs, by p.c.u. miles, has not been employed here because of the new evidence available on police costs suggest this is unreasonable. Further details can be found in the Annex 15.

Accident costs not covered by insurance: These have been allocated according to vehicle miles weighted by the relative frequency with which each vehicle class experiences accidents and according to the medical cost of the accidents in which they tend to be involved.

Table 8:3 Revenue/cost ratios by major vehicle category 1965/66

These figures have been calculated by comparing the costs as allocated and the revenue by each vehicle category.

Table 9:1 Vehicle Fleet 1965

These figures have been taken from Highway Statistics 1966. They represent the fleet at end September 1965.

Table 9:2 Revenue raised by applying car revenue/cost ratio to heavy goods vehicles 1965/66

This Table is self-explanatory.

Table 9:3 Revenue cost ratios by vehicle category assuming road haulage charge in force 1965/66

This Table has been calculated by applying the rates proposed for the road haulage charge to the vehicle fleet in 1965 and adding the revenue implied to the estimates already shown in Table 8:1.

Table 9:4 Tax paid by heavy goods vehicles by unladen weight category (excise duties and fuel tax) 1965/66

This Table has been derived from the Operating Cost Survey referred to above and from the scale of vehicle excise duties modified to allow for rebates. The dip in the middle of the scale is due to the switch to diesel engines which starts to take place at this point; these offer better fuel economy.

Table 9:5 Revenue/cost ratios for heavy goods vehicles before payment of road haulage charge 1965/66

This Table has been derived through a comparison of the revenue figures implied by the Table 9:4 and costs as allocated by the methods described in the Notes on Table 8:2. The notes on Table 8:2, however, does not indicate how costs have been allocated between various categories of commercial vehicle. The only items which need additional explanation are that part of capital costs which are incurred for heavy vehicles alone, and maintenance to the road surface. The former have been allocated according to the A.A.S.H.O.[1] formula which suggests that extra construction requirements vary in proportion to axle loadings raised to the power of two thirds. This method is unsatisfactory for a number of reasons which Annex 15 expands upon. The two most important points are: first, this formula refers only to construction thicknesses, while a large part of the expenditure specific to heavy vehicles concerns structures and gradient reductions. Second, it was derived from experiments conducted in physical conditions rarely experienced in this country. There is, however, little information available from other sources on which to base alternative allocations and as the general pattern resulting from its application appear reasonable, it has been used here. The effect of applying the A.A.S.H.O. formula is to allocate the bulk of these costs to vehicles over 3 tons unladen weight, since loadings below that level are small, but to make little differentiation between the larger vehicles per mile run, because of the low power used. It is obviously reasonable to expect that the weight related expenditures should be allocated on a rising scale. Although there is clearly no direct connection between weight related expenditures and the other types, it would be reasonable that these costs, too, should be allocated on a rising scale, since height and congestion effects are probably correlated with vehicle weight. The second item needing further explanation is surface maintenance. Again, as Annex 15 makes clear, no entirely satisfactory information exists on the relation between road wear and the use of the roads by particular classes of vehicle, and in particular there are grounds for thinking that the A.A.S.H.O. results are not applicable to this country. Accordingly, these costs have been allocated by using a cube law. This is not meant as an estimate at the true physical relationship but as a compromise between the A.A.S.H.O. 4th power law and the use of gross ton miles the two methods used in the Geddes submission.[1] Unlike the earlier submission no distinction has been drawn between preventive maintenance and repairs. Details of axle loadings obtained from survey data[2] were used in conjunction with data obtained from the Road Goods Survey 1962, to estimate axle loadings for different weights of vehicle.

---

[1] See Annex. 1

Table 9:6 Revenue/cost ratios for heavy goods vehicles after notional payment of road haulage charge 1965/66

This has been calculated in the same way as Table 9:3.

Table A5:1 Passenger car equivalents

This Table was taken from Research on Road Traffic (H.M.S.O. 1965), page 201.

Table A5:2 Passenger car equivalents of tracks on ordinary multi-lane highways

This Table has been adapted from Tables 10:10 and 10:2 of the Highway Research Board Highway Capacity Manual 1965.

Table A5:5 Vehicle mileage on all roads in Great Britain

This Table has been derived by applying the results of the continuous 50 point census to the results of the 1100 point census. All roads are in principle included. Because, however, the 50 point census does not cover unclassified roads and motorways, these two classes for road had to be treated separately. Virtually all motorway mileage is in rural areas and was classified accordingly, while it was assumed that unclassified road mileage broke down in the same proportions as those obtained by the 1100 point census.

---

[1] See Annex 2.

[2] See Annex 18.

Table A14 : 1 Numbers of general goods vehicles currently licensed 1960/66

This Table was derived from Highway Statistics.

Table A18 : 1–4 Axle loadings of heavy goods vehicles

As indicated in the text of the Annex, these Tables were calculated from the weighbridge data. These provided details of the weight of each axle and the unladen weight of the vehicle, as well as other factors such as body type. It was possible therefore to apply the A.A.S.H.O. 4th power law to the individual axle oadings and thus calculate a total weight for the whole vehicle.

Table A19 : 1 Estimated wear and tear costs of heavy goods vehicles

The relativities on which this Table have been calculated were obtained from he weighbridge data. The first column shows the relativities obtained by taking vehicles gross weights, the second, by raising each axle loading to the 3rd power and the third, by raising each loading to the 4th power. The middle column lies almost exactly halfway between the other two. The main difference between the first and the third column is that the former places a greater share of the total cost on vehicles under 4 tons unladen.

MINISTRY OF TRANSPORT

ROAD TRACK COSTS

A report by the Ministry of Transport

The White Paper on The Transport of Freight (Cmnd 3470) referred to the Ministry of Transport's economic research programme and its contribution to policy making. This paper presents some of the results of this research progamme.

LONDON
HER MAJESTY'S STATIONERY OFFICE
1968

CONTENTS

Page

CHAPTER 1. Introduction 1

2. The costs of using and providing roads 4

3. Estimates of road costs 1965/66 and 1975 10

4. Road revenues 1965/66 and 1975 13

5. The relationship between total costs and revenues: commercial and economic approaches... 15

6. The relationship between total costs and revenues: fiscal considerations... 23

7. The allocation of costs to vehicle classes: the benefit/cost approach 25

8. The allocation of costs to vehicle classes: the cost responsibility approach 29

9. The road haulage charge 33

10. The way ahead 38

ANNEXES 40

NOTES ON TABLES 114